THE EAST AFRICAN AGRICULTURAL JOURNAL

of

KENYA
TANGANYIKA
UGANDA AND
ZANZIBAR

IMPERIAL MYCOLOGICAL INSTITUTE
1 JAN 40

Vol. V—No. 3

NOVEMBER
1939

IMPERIAL MYCOLOGICAL INSTITUTE
1 JAN 40

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IN THIS ISSUE:

PLANT PHYSIOLOGY AND AGRICULTURE

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NOTES ON THE USE OF STRIDING LEVEL WHEN LAYING OUT CONTOUR BANKS

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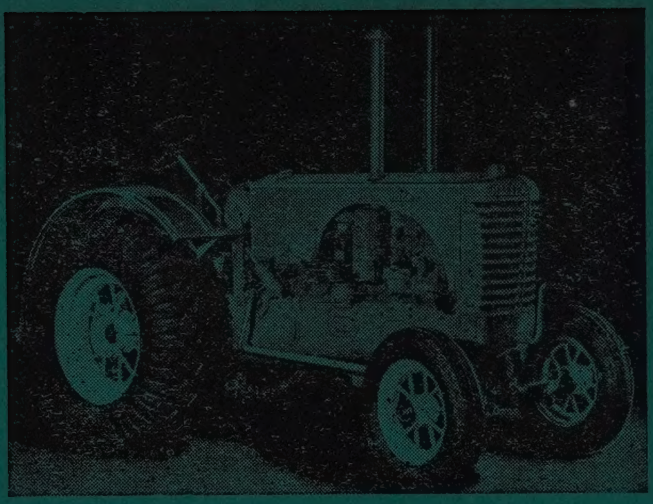

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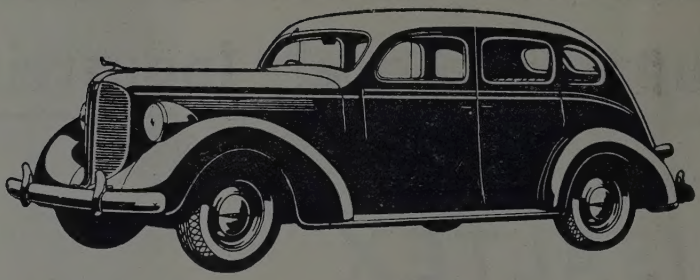

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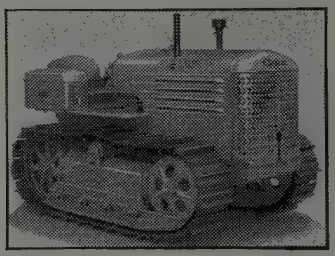

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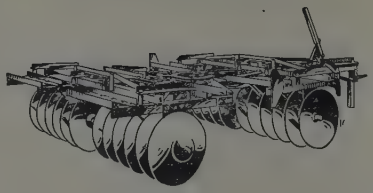

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JANUARY, MARCH, MAY, JULY, SEPTEMBER, NOVEMBER

Editor:
Director, East African Agricultural Research Station, Amani.
Editorial Board:
Directors of Agriculture, Kenya, Tanganyika, Uganda, and Zanzibar.
Assistant Editors:
G. Milne, Amani; J. B. Gould, Department of Agriculture, Nairobi.

Subscription 5/- per annum, or 1/- per copy, post free, payable through any Agricultural Officer, or to the Government Printer, P.O. Box 128, Nairobi, to whom all business communications should be addressed. (Subscribers are advised to remit postal orders in payment, otherwise bank commission must be added in the case of cheques.) Editorial correspondence should be addressed to the Editor, Amani, via Tanga, Tanganyika Territory.

The Editor does not hold himself responsible for opinions expressed by contributors.

Matter submitted for publication should preferably be sent through the local member of the Editorial Board. Manuscripts should conform with the recommendations contained in *Notes for Authors*, which may be obtained from the Government Printer, Nairobi, or from a member of the Editorial Board.

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Readers are reminded that all agricultural inquiries, whether they relate to articles in the Journal or not, should be addressed to the local Direcor of Agriculture, and not to Amani.

THE JOURNAL IN WAR-TIME

Since the printing of our last issue war has been declared and we have entered into a period which is likely to influence the whole outlook of our future lives and bring about many changes in the social order to which we shall have to adjust ourselves in the months to come. As far as can be seen at present, East Africa is unlikely to develop into the war zone that it became in the Great War. Instead, it would appear that the part we are destined to play this time is in the economic field, which in modern warfare is a no less important role.

Compared with most tropical territories East Africa, because of its wonderful highland areas, is particularly fortunate in being self-supporting as regards most European food supplies, having a surplus of some. This is an invaluable asset in time of war, and one that the Home Country will need to call upon to the fullest possible extent, as supplies of essential foodstuffs from certain markets are likely to be obtainable in diminished quantity and may even be cut off altogether. At the time of writing we do not know what demands may be made by Britain on our producers, European and African, but it seems almost certain that the Home Country will need our surplus of essential European foodstuffs up to the limit of our production capacity. What our war-time productive capacity will be is hard to estimate, as many European farmers in East Africa, because of military or other duties, have temporarily

gone out of production, so that unless the loss of their services can be made good by placing a heavier burden on others no spectacular increase in production seems probable. In the case of Tanganyika the large number of male enemy aliens who have had to be interned will also affect production for the time being, although this loss may be more than compensated for by increased production by Africans.

Again, as the result of a series of lean years, most farmers have no surplus funds for investing in new developments, and for this reason fresh capital will need to be found from other sources to finance expansion. That production will be increased in spite of these handicaps we have no doubt, but in achieving this much may be expected of our farmers, men and women.

Whatever the war-time troubles of the East African producer may prove to be, it is earnestly to be hoped that the desire to achieve quantity production will not be accompanied by any falling-off in quality, for in this way danger lies as irreparable damage would be done thereby to our future export trade. Nor must the possibility of increased soil erosion under extended cultivation be forgotten. The fate of large areas of the world made sterile by erosion following on the powerful stimulus given to wheat production during the Great War is still before us as a sad reminder of the danger of uncontrolled expansion.

With regard to the conduct of this Journal during the war, no change has been made in our policy excepting in so far as it is proposed to devote attention to the problems that will arise owing to the changed conditions under which agriculture will now have to be conducted. Our aim will be to reflect the policies of the East African Agricultural Departments whose directors are members of our Editorial Board. Pending the development of the war, these policies have not yet been published collectively, but it is safe to say that they can be expressed by Mr. Wolfe's slogan of "Farming as usual, *plus*."

The production of the Journal during the war may prove to be a difficult undertaking and will depend on such factors as paper supplies and the continuation of support from our subscribers and contributors, without which no effort on our part will avail. May we count on this support, and ask you to assist by sending us contributions for publication on subjects related to the altered conditions under which we must now live and the change-over from a peace to a war economy in farming?

A.G.H.

Sir Frank Stockdale's Report on his visit to Malaya, Java, Sumatra and Ceylon in 1938 [1] takes the form of a descriptive commentary on current agricultural research activities in those countries and on noteworthy aspects of estate practice or of peasant production. The background of geographical conditions, soils, marketing questions, rural economics, agricultural education and miscellaneous matters is filled in sufficiently to engage the interest of readers who have no personal knowledge of the East Indies, and much of the commentary will for that reason have a wider application than only to the region it specifically deals with. Rubber and rice are Sir Frank's chief topics in Malaya; he passes on through coco-nuts to pine-apples; crosses the strait into Dutch territory to discuss tea and coffee, sugar, quinine and sisal; and looks in briefly at Ceylon on the way back, to note progress (but wish for more) in soil conservation.

[1] Issued by the Colonial Office, C.A.C. 454, April, 1939.

Some of the discussions are worth summarizing for East African readers in more detail than is possible in a short notice, and this we are endeavouring to arrange for in a subsequent issue. Thus the long section on the rice industry of Malaya might be studied here with profit, even though the setting is so different. An article printed in our present issue shows that rice can be grown in Kavirondo to yields that compare extremely well with the yields per acre obtained in the world's great rice-growing countries; and that this is true also for another part of the Lake Victoria coastlands, near Mwanza, is shown by departmental publications recording results at Mwabagole, an experimental farm of the Tanganyika Agricultural Department. Possibly in rice-growing in the Lake Basin there is a field of effort that would repay further development.

There are some interesting references to manuring, of which one relating to a tree crop may be quoted. While it is concluded that "the manuring of rubber more than 25 years of age is of doubtful value and it is deemed to be uneconomic where the general vigour of the trees is poor and the yields low," yet in young rubber "the plantations have to be seen before it can be fully realized what marked differences do occur when phosphates are applied. . . . In some instances the applications of phosphates are beneficial even when land is brought into cultivation from good jungle. . . . Only relatively small quantities per acre are needed, and rock phosphates are as effective as the more costly forms of phosphatic manures. . . . Budded rubber manured with phosphates is large enough for tapping to commence at least one year before it would otherwise have been." The manuring of young rubber on replanted areas is regarded as essential and a complete inorganic fertilizer is at present recommended.

Rubber ranks only as a minor product in East Africa as a whole (though it was fourth highest in value amongst the crops providing Uganda exports in 1938), but other tree crops are major elements in our agricultural scene, and such references as that just quoted are a reminder that the possibilities latent in a more extended use of fertilizers are worth our continued attention. Consulting the *Annual Trade Report* of Kenya and Uganda, we find that the total import of fertilizers through Mombasa in 1938 was 2,576 tons, valued at £14,750. This is not a negligible amount: calculations from the export tables, making average assumptions regarding the composition of the chief exported products in respect of manurial ingredients, show that if the imported fertilizers had all been phosphates they would approximately have balanced the outgo of phosphoric acid, contained in maize, coffee, etc., sent through Mombasa in the same year, though a large item of about 1,500 tons of P_2O_5 sent away in the form of cotton-seed, chiefly from Uganda, remains in the account uncompensated. The amounts of fertilizer imported have been increasing in recent years; the growing importance of the trade is indicated by a reference in the *Annual Report of the Kenya Department of Agriculture* to the desirability of promulgating a Fertilizers Ordinance. Yet if we imagine the 1938 imports of fertilizers and manures as spread over the 11,000 square miles of agricultural land in non-native occupation in Kenya (for presumably but little goes to native farmers) they represent no more than 13 ounces of mixed fertilizer per acre, involving an expenditure of just over 4 cents of a shilling. The next item above in the blue book schedule catches the eye—Blacking and polishes: imports, £13,094. Do we spend nearly as much on polishing our boots as we do on buying back fertility? G.M.

We wish to ask our contributors not to employ vernacular words without an explanation of their meaning. We ourselves have, of course, passed the Lower Standard Swahili Examination; but that was many years ago, and even then we only scraped through by inviting the examiner to a sundowner on the previous evening. But this Journal is (at least, we hope that it is) widely read outside East Africa, by people who cannot be expected to have any knowledge of Swahili, not to mention some of the other languages with which authors occasionally interlard their contributions. It is often difficult for us, here, to ascertain the correct meaning of a native word, while to refer the matter back to the author entails considerable trouble and delay. For instance, an article recently submitted contained the word *cheche,* clearly an animal of some sort, but exactly of what sort we were at a loss to know. We questioned Gabriel (not the Archangel, who would of course have known, but our office-boy), but the best he could do was *nyama sawa sawa paka* (an animal like a cat). Consulting Bishop Steere's Handbook, we found that *cheche* is "a brown mangouste". This seemed to be helpful, but what is a mangouste? Reference to the Oxford English Dictionary was unavailing; the word is not to be found. Oxford may be the home of lost causes, but evidently not of stray mangoustes.

It seemed likely that the word was a Lewis Carroll "portmanteau" for *langouste* and mongoose, but that such a hybrid should really exist is against all the principles of zoology. Then dim memories stirred of that almost forgotten Swahili examination. Surely the word "mangouste" was not entirely unfamiliar? So we referred to Steere's Swahili Exercises, which had been the textbook for the examination, and found therein a mine of information—

"The simpletons are overturning themselves."

"The idle slaves are scratching themselves."

and, yes—

"The savage mangouste is biting the idle cook."

But on looking at the key, it appeared that this was a different sort of mangouste —an *mchiro,* not a *cheche* at all.

So we still do not know whether a *cheche* is the animal we have been looking for—for we already have the idle cook.

T.W.K.

FABLE

A Dairy Farmer experienced trouble with his Cream, which was consistently graded down at the local Butter Factory. A Visiting Instructor could find no fault with the Plant, the Utensils, the Methods of Production or the Water Supply, and the Dairy Itself was Clean.

But the cows' Drinking Water was pumped by windmill from a Well to a Storage-tank, and thence to a nearby Trough. Carelessness had resulted in the tank overflowing, and a Bog had formed near the trough. Through this Mud the cows had to Wade, and it splashed on to their Udders and Flanks.

Then the farmer fenced off the bog and made his cows approach the trough from the Dry Side. He also washed their udders and teats with water to which a little Sodium Hypochlorite had been added. He cleared away all Manure near the dairy premises and spread Slaked Lime about the cowyard and bails.

And there was no more Ropy Cream.

—The incident was reported in the *Agricultural Gazette of New South Wales* for April, 1939.

PLANT PHYSIOLOGY AND AGRICULTURE*

By H. R. Barnell (Low Temperature Research Station, Trinidad)

Introduction

The green plant, directly or indirectly, is the food of man, while agriculture is the industry concerned with the production of food for the world's population. The primary occupation of agriculture is therefore the culture of the plant, the efficiency of the industry depending on raising the maximum amounts of produce without loss of assets in terms of soil or its fertility. In the past, empiricism, or the method of trial-and-error, has resulted in the evolution of methods of plant and land culture which have been "efficient" in the sense of providing a sufficiency to meet the demand made on the produce of the land by its inhabitants. But as this demand increases, or as present systems of production become uneconomic, the old method of seeking to effect improvements in cultivation may not only prove cumbrous, slow and labour-wasting, but may also exercise a restricting influence on the utilization of valuable innovations inherent in scientific discoveries. The view may therefore be advanced that every effort should now, and in the future, be made to approach the problems of agriculture through the medium of fundamental research in plant physiology. In practice the appropriate combination of empirical and fundamental methods is likely to be most productive of useful results.

The Assessment of Yield

The problems of satisfying increased demands for plant products, or of raising the returns on a particular crop to a profitable level, resolve themselves into the question of "yield". The yield of a plant may be the whole mass of plant produced, its fruit, its seed, its stem or its roots or some part of any of these, or appendages. Yield is determined by hereditary constitution and by the conditions under which the plant has been grown; it can be regarded as the integration of the metabolic processes concerned in growth and development until the harvesting period is reached. It follows that before the factors determining yield can be analysed with any exactitude it is necessary that our knowledge of the fundamental problems of plant metabolism should be greatly increased; only then may the effect of variation in any one environmental factor on the life of the plant be forecast with assurance. The only way, in fact, in which the ideal of providing a plant with the most favourable environment for producing its maximum yield can be attained is by the study of metabolic processes and their reactions to varying external factors. Until this information is available we cannot even suggest a value for the maximum yield of a particular crop and hence we have no fixed standard by which to assess the "efficiency" of present-day systems of cultivation. Of new systems introduced to-day it can only be said that they are improvements or otherwise on past systems.

The maximum yield of a plant will be obtained when its environment is so arranged that its many metabolic processes are collectively functioning under optimal conditions throughout the life of the organism. Any plant of the same genetical type which is not producing this maximum yield may then be considered to be "pathological", i.e. suffering from an excess or deficiency of some environmental factor or from the attack of a parasitic organism. It is safe to say that, judged by

* Reprinted from *Tropical Agriculture*, Vol. XV, No. 6, pp. 123-125.

this physiological ideal of maximum yield, very few crop plants to-day would be regarded as "non-pathological".

Scope and Limitations of Modern Plant Physiology

In its modern form the science of plant physiology is barely adolescent; no one of the fundamental problems of plant life can be said to be fully understood. Work is still being carried out on the mechanism of photosynthesis, respiration, transpiration and translocation in plants. While some partial efforts have been made, there has not yet been completed anything that may justly be regarded as affording a full physiological and biochemical study of the development of a single plant.

In the agricultural industry the application of plant physiology has so far been of limited extent, and has largely consisted in "explaining" the various current modes of cultivation. For example, modern study has shown that major operations such as ploughing, liming, supplying humus, etc., all tend to increase yield by increasing the available supply of nutrients to the plant—a direct consequence of keeping the soil "open" whereby more efficient aeration and rapid oxidation of the weathered rock become possible. This preliminary elucidatory phase of the application of plant physiology to agriculture represents the essential "catching up" of a new science to an ancient industry; in brief, it has been necessary for the science as a first aim to understand as far as possible the fundamental nature of practices at present in operation.

The next approach is to suggest from knowledge of the plant's metabolism improvements on existing methods. It is the purpose of this article to consider the application of fundamental research in plant physiology to agriculture and the results which may be expected to accrue. Already in one branch of the industry—the transport and storage of perishable agricultural produce—it may be claimed that physiology has taken its place and that from an early stage fundamental researchers have played their part in preparing the way for extended commercial application. In no other branch of agriculture has plant physiology yet had such an opportunity to contribute, but it will be of interest to consider its present bearing on the industry in general.

The basis of agriculture is the green plant grown in the soil. The plant requires from the soil: anchorage, nutrients and water, the last two in suitably balanced quantities. For physiological studies, however, sand or water cultures are preferred, as, in general, better and more uniform plants can be produced than in soil, which rarely contains the right balance of nutrients or possesses the best physical state for the encouragement of growth; moreover, soils vary considerably in physical and chemical composition even when obtained from a limited area of land. Intensive agriculture (particularly glasshouse culture of fruit and vegetables) is tending more and more to apply sand or water instead of soil culture to its crops because of the more standardized growing conditions obtained and the consistent better yields produced. Agriculture in general, however, must of necessity remain content with the soil. The aim of applied physiological research will be to attempt to ascertain the best use to which the soil and prevailing climate can be put. As knowledge of the interaction of plant metabolism with external factors increases, the selection of plants to suit particular environments should become a matter of less uncertainty than at present. Cultivation methods will also be modified to provide the nearest approximation to the environment most favourable for the plant.

PHYSIOLOGY AND PATHOLOGY

The extension of a single crop to large-scale production usually brings numerous problems in its train, among others liability to disease in epidemic form, e.g. the onset of Panama and leaf-spot diseases of the banana plantations in Central America and the Caribbean. It is cogent to inquire what assistance the physiologist is likely to be able to render in the future to the pathologist in his efforts to reduce such diseases. Since some aspect of every disease are referable to derangements of the normal metabolism, it follows that for the full understanding of the pathological condition physiological investigations will also be required. The difficulties in the way of general advance along these lines at present lie in the relatively slow rate of advance of physiological knowledge due, in part, to the few workers engaged in that science. It is not possible to carry out more than a superficial investigation into the disordered metabolism of a diseased plant while the metabolism of the healthy plant is not understood. (For practical purposes a "healthy" plant is here understood to be one showing no apparent symptoms of disease and, if a crop plant, providing a satisfactory yield.) Thus, one of the results of an attack of leaf-spot (*Cercospora musae*) disease of bananas is premature ripening associated with abnormal colour, flavour and odour of the pulp; while the causes underlying the initiation of ripening in the healthy banana remain unknown, only provisional hypotheses can be made concerning the manner in which the fungal attack diverts the normal metabolism of the fruit. All too frequently in the early days of plant pathology a disease was considered adequately investigated and the problem, so far as agriculture was concerned, closed once a causal organism has been found, named, and some control measure suggested; whereas the discovery of a causal organism (or of the absence of such an organism in so-called "physiological diseases") should, in fact, be regarded as a starting point for specialized physiological study both of the pathogen and its host.

Except in those instances where a plant is genetically weak, all morbid metabolic states are attributable to external factors. These may include: a deficiency of water supply; deficiency of some essential element in available form; deficient oxygen supply due to overcrowding or to waterlogging of root systems; excess of some element or elements or carbon dioxide; or the external factor may be an alien organism which competes for the synthesized food materials of the plant and, perhaps, simultaneously secretes a toxin having an additional deleterious effect on the metabolism of the plant. Any combination of one or more of the above factors may be responsible for disease; in all cases the disease is a diversion of the normal metabolism of the plant as grown under ideal conditions.

A single factor, the excess or deficiency of which, in conjunction with the inroads of parasites, is responsible for more pathological conditions than any other, is that of water supply. Water in excess of a plant's requirements, or presented unequally so that periods of excess occur, though the rainfall over the whole season may barely provide an adequate supply, results in waterlogging of the roots, decreasing the respiratory activity of their tissues by reducing the rate of diffusion of oxygen to their surfaces, causing stunted root development with consequent poor growth of the whole plant and inability to cope with temporary drought periods. Water deficiency in the soil results in many pathological symptoms, including wilting, little-leaf, defoliation, and stunted growth generally.

These examples represent part of the toll of disease due to variations in the

intensity of a single factor of the plant's environment. Each of the other environmental factors (nutritional and other elements in the soil, oxygen, light, etc.) may be present in excess or deficiency and each add its quota of possible pathological states. Combinations of various deficiencies and excesses will produce complex abnormal plant growth. The optimum intensity for each factor can only be elucidated by research, which is made particularly difficult by the interdependence of the factors in their effects on the plant (e.g. light intensity and temperature, temperature and water supply). Fortunately each variety of plant can tolerate a more or less wide range about the optimum intensity of each factor without any serious pathological condition being induced.

Plants growing under conditions near the limit of their range with respect to a particular factor may be subnormal and therefore less resistant to attack by those parasites for which the conditions are nearly optimal. Thus fungal parasites in general grow and spread most rapidly under conditions of abundant water supply and high humidity, hence crop plants already partially crippled by conditions of waterlogging are liable to more virulent infection by fungal pests than those grown under more satisfactory conditions of water supply.

Restoring conditions to a closer approximation to the optimum for a crop's growth will assist in the combating of alien organisms producing specific diseases. Thus, draining modifies conditions in the right direction for crops suffering from excess of water, while the application of fertilizers to supply deficient essential elements in the soil also modifies the plant's environment but in a complex manner.

The influence of environmental factors on the incidence of disease has been much discussed by pathologists and numerous investigations have been carried out both in the field and under controlled conditions. As a result the conditions favouring disease incidence or otherwise are now at least partly known for many diseases of major importance. Nevertheless, to obtain the desired measure of control it will be necessary to carry the analysis of disease problems far beyond the present stage.

Complex Action of Fertilizers

Fertilizers, as mentioned in the preceding section, act on the soil and on the plant in numerous ways, the understanding of which is not easy. Addition, in available form, of an element definitely demonstrated as deficient in the soil is almost invariably beneficial, but in exceptional cases it may so disturb the balance of the chemical-physical biotic soil complex as to produce deleterious effects on plant growth. The modes of action of a fertilizer on the soil and on the plant are too numerous to discuss at length, so are briefly summarized:—

(1) The physical properties of the soil are altered.

(2) Availability of other soil constituents may be affected.

(3) Concentration of the soil solution is changed.

(4) Reaction (pH) may be altered.

(5) Balance between certain soil constituents, e.g. magnesium-calcium antagonism, may be corrected or disturbed.

(6) Biotic balance (bacteria, nematodes, etc.) is modified.

(7) May act as toxin towards plant or may protect against toxins already present.

(8) May serve directly as a plant nutrient.

(9) Decreases "water requirement" of plant, increasing efficiency in utilization of scanty water supply.

(10) When absorbed by the plant increases its resistance towards specific diseases, e.g. salts of lithium increase resistance of wheat to mildew (*Erysiphe graminis*), Spinks (1913), Wortley, W. R. S. (1936).

(11) May render plants poisonous to pests, e.g. selenium salts and thrips on cotton: Mason, T. G., and Phillis, E. (1938).

It is clear that with so many diverse actions of a fertilizer on the soil and on the plant many important changes may escape detection in empirical experiments and much possible information be neglected. Even when the yield is not increased, in a trial with a particular fertilizer, biochemical and physiological study may reveal differences of fundamental importance. Once comprehensive knowledge is available concerning the metabolical and morphological reactions of a plant to variations in its environment, much greater use than is possible at present could be made of the plant as an indicator of the soil and climate in which it is grown, pointing the way to success or failure of other crop plants grown under similar conditions.

Importance of Fundamental Knowledge

In the past empirical methods have given sufficiently good results in agricultural research, but only after long experience. The *tempo* of modern life demands that problems shall now be attacked by methods likely to give speedy solutions. Such methods must essentially be based on an exact knowledge of the functions and requirements of the plant, whereby the best conditions for its culture can be deduced with some considerable degree of exactitude. Empirical methods will almost certainly also be required for the final testing of deductions from physiological science but their application will be much more in the nature of a crucial experiment than heretofore.

For example, in modern fruit storage investigations, by studying the metabolic activities of a particular fruit in relation to each of the several external factors (temperature, humidity and gaseous composition of the atmosphere) information should be obtained indicating approximately the most favourable storage conditions: empirical trials can then be confined to a small range, and will therefore gain both in accuracy and value. So, too, in crop production, increase in fundamental knowledge should decrease the amount of empirical work necessary and materially advance the solution of practical problems.

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"The soil demands a dominant. If white men will not and black men cannot assume the position, the vegetation will do so. For the tropical environment is so delicately balanced that the soil must have a firm ruler, or chaos will supervene."

—*The Rape of the Earth.*

"Good husbandry consists not only in producing but in continuing to produce good crops. If we wished to distinguish between agriculture and soil conservation, we might define agriculture as cultivation for present production and soil conservation as cultivation for future production."

—*The Rape of the Earth.*

FRENCH BEAN DISEASES AND BEAN FLY IN EAST AFRICA

By G. B. Wallace, B.Sc. Agric., Ph.D. (Edin.), Plant Pathologist, Department of Agriculture, Tanganyika Territory

During the past year planters in the Tanga and Northern Provinces of Tanganyika Territory have inquired what explanations can be offered for the poor growth and low yields that have been obtained with French beans. The present article calls attention to factors which are in a considerable degree responsible, and it should encourage planters to a renewed interest in the crop.

The market price, while not high, has in itself not discouraged bean culture, but together with low yields and poor appearance of the harvested beans it has reduced the acreage in recent years. Higher yields and better appearance, both of which are possible, will to a large extent off-set low average prices.

The factors to which reference is now made are the bacterial disease Halo Blight, Common Mosaic and other diseases, and an insect pest, the Bean Fly. Officers in the Kenya and Uganda Departments of Agriculture have been consulted, and have kindly provided local information on the major parasites discussed; their assistance is gratefully acknowledged.

Halo Blight

(*Phytomonas medicaginis* var. *phaseolicola*)

The first record of bacterial disease in French beans in East Africa was made in Kenya Colony in 1931. *Phytomonas phaseoli* was the organism suspected, but this was amended subsequently to the name given above. At the end of 1937 the same disease was observed in Tanganyika Territory, but recent examination of museum material shows the disease to have been present in the Territory in 1929.

There are several other bacterial diseases of French beans recorded outside East Africa, but the symptoms are very similar and the control measures are the same, except in so far as the use of resistant species of beans is concerned.

Halo Blight is well known in other countries and has been the subject of some research. The most detailed study of bacterial diseases generally, in French beans, is that by Burkholder. [1]

Symptoms of Halo Blight

In order to make local observations on the disease, a number of varieties of French beans were grown at Lyamungu in 1938. All the above-ground parts can be infected and show external symptoms, but in a dry year, such as 1938, only the leaves and to a less extent the seeds show recognizable disease.

The organism occurs in and on the seeds, from which it spreads to other parts. Splashing by rain may spread the organism on to other organs or to other plants. Spreading within the plant takes place through the vascular system.

The general symptoms are stunting of the plants and wilting of first the lower leaves, and later the upper leaves, shoots, pods and seeds. Symptoms on the leaves vary. The name Halo Blight arose from the occurrence of a type of leaf-spot in which a pale-green zone surrounds a necrotic dry and brown area. The size of

the latter varies, and the halo is half to one inch in width, but even a small spot may be surrounded by a relatively wide halo. Quite usual also are small angular brown spots bounded by the smaller veins.

The most common leaf symptom seen in 1938 was relatively large dry brown areas; these are brittle and easily broken by wind. They arise either towards the end of the leaf or at the margins; on their inner sides they have a wide pale-yellow border. Many leaves show numerous small pale areas bounded by darker green parts lying along the veins, giving a mosaic effect, not to be confused with the virus mosaic of beans referred to below.

As the weather in 1938 apparently discouraged stem and pod symptoms, the following notes are taken from the descriptions by Burkholder. [1] Longitudinal streaks appear on stalk, branches and petioles. On seedlings such lesions are water-soaked and dark green, and may become somewhat reddish. This water-soaked condition is apparently not so evident in older plants. Longitudinal cracks may also be seen. A characteristic feature of this particular disease is the occurrence of droplets of bacterial ooze on the surface of the stem; these droplets are colourless or milky. (They have not been seen on the local material.) On the pods more or less circular spots appear; at first they are green and water-soaked, but later may dry out and become sunken and reddish-brown in colour. Irregular lesions may be formed along the suture.

Diseased seeds are easily recognized by the presence of raised blisters of a yellow or orange colour. These may be seen on a high proportion of seeds in a wet year such as 1937, and on very few in a dry year. Severely infected seeds are small, and may be completely coloured and blistered.

Control of Halo Blight

The varieties marketable as seeds (as distinct from green pods, for which there is no local market) are all more or less susceptible. In Kenya efforts are being directed towards breeding resistant strains of the popular varieties. Such work is necessarily slow, but results so far are reassuring and this may prove the most satisfactory solution to the problem.

Besides French beans, Madagascar and Lima beans are susceptible. Where such species or varieties are to be grown in an endemic area, the following routine is advisable for control.

Care should be taken in the choice of seed. Preferably it should be taken from a healthy crop, and should be sown in fresh ground where no susceptible species have been grown for at least three years. It should not be soaked prior to sowing.

When a planter wishes to collect seed from his own crop (which is to be recommended), a small plot should be sown away from the main crop. On that plot the seed should be sown singly and fairly wide apart. The plants should be examined at intervals, and those suspected to have blight rogued out. The harvested seeds should be examined, and only those that are quite healthy should be kept for future sowing.

Where the disease is severe, fallen leaves and old bean vines should be collected and burned. This should be done without delay in order to destroy any bean fly that may be present (see below).

Should adequate control be found difficult by these measures, it may be advisable to grow some other species of legume resistant to the disease. Resistant legumes are Soy, Adkuzi, Bonavist and broad beans, gram, cowpeas and field peas. The following are also resistant: Kudzu vine, white sweet clover, and lucerne.

Other Diseases of French Beans

Rust (*Uromyces appendiculatus*) is widespread and is probably the bean disease best known to planters. It is at once recognized by the orange-coloured spores, which arise chiefly on the lower surface of the leaves. On a fresh green leaf each spore cluster is surrounded by a pale green ring. A heavy infection results in leaf-fall and reduction of crop.

Like the bacterial disease, rust is encouraged by high humidity. Where the disease is normally severe it may be advisable to sow late, towards the end of the rains. The use of fungicides on beans is normally too costly, but it may pay on a valuable crop such as that grown for seedsmen. In that case sulphur, which is recorded to have given better control than Bordeaux mixture, should be applied at the rate of 70 lb. per acre as soon as the disease appears; a second application may be necessary a week later.

Rust-resistant varieties of French beans exist, but the colours of their seed coats are not in their favour. Among Lima beans, Wood Prolific, Sieva and Henderson are resistant. Among runner beans the hard-husked varieties are said to be normally more resistant than those of softer texture.

Common Mosaic is a disease already recorded on beans in Kenya. It was observed at Lyamungu in 1938. It is caused by a virus and is spread by aphids. The mosaic symptoms are more marked than those sometimes associated with Halo blight (see above), and can occur in the apparent absence of other symptoms of that disease.

Affected plants are mostly small. The leaves are distinctly mottled with yellow, pale green and dark green areas, and show a characteristic downward cupping of the edges. The leaflets are mostly small and the petioles long in proportion. The pods, if present at all, may be small, twisted and warted.

In California, Smith and Hewitt [11] in their studies of this disease in their selections of a large number of varieties found that a correlation exists between the severity of symptoms and the percentage of seeds transmitting the mosaic from plants inoculated in the seedling stage.

The best control of mosaic is to rogue the plots early in the season, particularly those from which seed is to be taken for sowing. Early maturity enables a crop to mature its seeds before the aphids that transmit the disease can become numerous. Aphid vectors in the United States are *Macrosiphum solanifolii* (the pink and green potato aphid), *Aphis rumicis* (the black bean aphid), and *Myzus persicae* (the peach aphid). The last two species are recorded in East Africa.

Varieties with dark green foliage were found by Ogilvie and Hickman [10] to be more resistant. Strains of several American varieties have been bred for resistance; seed will be obtained for trial under local conditions.

Anthracnose (*Colletotrichum lindemuthianum*) is a common fungus disease of beans, but has not been found severe locally. It forms dark sunken spots on stems, leaves and pods, and may penetrate the pods to the seeds. The varieties Princess (white seeds), Selected Canadian Wonder (dark purple seeds) and others were found by Ogilvie and Hickman [10] to be resistant.

Yeast Spot (*Nematospora coryli*) is widespread, but varies in intensity. Host plants of the parasite and the symptoms were recorded by the author [13] in a recent number of this Journal. Control is a difficult problem, but the disease might be kept within reasonable bounds if the crop is grown away from other susceptible species and if indigenous hosts can be

kept down. As the disease is spread by bugs, a satisfactory control for the latter is very desirable.

Other bean diseases are known throughout East Africa, but are not generally important. Hansford [4] in Uganda has listed a considerable number.

Bean Fly

(*Agromyza* (*Melanagromyza*) *phaseoli*)

The bean fly has been known for many years in tropical and sub-tropical countries. In Tanganyika Territory it was recorded in 1936 by Harris [2] [3], who referred to its larvæ "boring into the stems of haricot beans at the collar, causing total loss of crop." A diseased specimen of cowpea collected at Tanga in 1932 was found, on recent examination, to have empty pupal cases of an Agromyzid. The pest caused 50 per cent loss of French beans on one estate in the Usambara Mountains in January, 1939, and a total loss on some acres in the Moshi district at the same time. In the latter district also, several smaller plots of French beans examined at that time were found heavily infested.

In 1926 Hargreaves [5] recorded the larvæ of a chloropid(?) fly attacking the stems of *P. vulgaris,* causing the death of the plants. Hargreaves states (*in lit.*) that flies reared from that material have been identified as *Melanagromyza sojae* Zehnt. (?) by van Emden. A hymenopterous parasite was reared from the larvæ.

In June, 1939, the Agricultural Officer, Kigezi, in Uganda, sent Hargreaves a bean stem showing damage identical with that of the 1926 finding. No fly (but one Braconid parasite) was reared. The sender said the pest was quite serious locally.

In April, 1939, Mr. M. Halcrow, Agricultural Officer in the Kenya Agricultural Department, kindly informed the author regarding observations he had made during the past six months on the subject of bean fly, recently identified. These observations leave no doubt about the importance of the pest in Kenya. Briefly, Halcrow has found that the pest may vary in intensity from farm to farm in one area and could be either very severe or not really obvious. It was observed at Njoro, Rongai, Subukia and Nairobi, with intensities varying up to 100 per cent. A Braconid parasite was obtained in 50 per cent of cases during October and November.

The reason why the pest is not better known in East Africa is doubtless the small size of the insect, viz. about 2 mm. in length. The primary injury it causes is also rather easily overlooked, since it is mostly at ground level. Information is required on the distribution and injury caused in other districts and at other seasons, particularly in the main growing period during and after the heavy rains.

Symptoms of Bean Fly Injury

Attention is first called to the presence of the insect in a field by the stunted and yellow appearance of many of the plants. Only a small crop or none at all may be formed before plants succumb.

The injury once seen is unmistakable. The collar is swollen and brown and the skin is raised and cracked; the effect is a gall with rather a cankerous surface. The fly lays its eggs on the leaves, and later the tiny cream-coloured larvæ can be found tunnelling in the inner tissues of the collar and stem. After an interval of ten to twenty days the larvæ pupate under the loose bark.

Investigations in Java [12] and elsewhere have shown that the total length of the life-cycle from egg to adult varies considerably with altitude and temperature, e.g. in Java it varies from 21 to 47

days. A number of generations are possible in one year. In the Tanga and Northern Provinces of Tanganyika, larvæ and pupæ were found in January. In February only pupæ were seen, and by the end of the month the flies had emerged from all pupæ examined. The period from February to March or later, when the main crop is sown on some estates, is doubtless bridged by the insect in plants remaining in the ground or in volunteer plants and leguminous weeds. In April of this year, 100 per cent infestation in Canadian Wonder beans was observed by Halcrow near Nairobi.

Besides French bean (*Phaseolus vulgaris*) and cowpea (*Vigna unguiculata*), the following host plants are recorded in the literature: *P. lunatus* (Lima bean), *P. semierectus* (a possible green manure and fodder crop), *Dolichos hosei* (a cover crop), *Crotalaria juncea* (Sunn hemp, a fibre and green manure crop), *C. quinquefolia* and *C. retusa.*

Other Agromyzids parasitize other leguminous crops, usually in the leaves and seeds; a species is known in the pith of the stems of soy beans and other plants in Java. Hargreaves states (*in lit.*) that *M. chalcosoma* is a common and serious pest of *Cajanus indicus* seed, and has been bred from galls on the stem of brinjal and of *Solanum* sp. (*katengotengo*). A further record of the genus is said to be *Melanagromyza* sp., not in the British Museum collection, mining leaves of *Crotalaria juncea* at Kampala in 1938 (a minor pest), and the same species, apparently, mining leaves of *Momordica fœtida,* a Cucurbit, at Kampala in 1933.

Control of Bean Fly

The experience in other countries shows that this pest is difficult to control. Since no one measure is completely effective, it is necessary to put into practice every method which can in any way assist in controlling the pest, so long as this can be done with economy. The measures advised are described below. As knowledge is obtained of the life-history of the fly in different bean areas of East Africa the suggestions will require to be amplified.

In the first place, reservoirs of the insect during the dead seasons of the crop should be eliminated so far as possible. These reservoirs could be plants remaining after harvest, volunteer plants from self-sown seeds, and any local indigenous hosts. As already stated, Crotalaria species are known hosts of this pest in other countries and may be so here, but other legumes, both crops and weeds, should be examined and dealt with if found infested.

Successive crops of susceptible legumes should not be grown if this can be avoided. The longer the interval between crops the better; this applies to vegetable gardens also, where beans are frequently grown all the year round, and thus constitute a source of infestation to neighbouring field crops. In New South Wales, where the insect has been known as a destructive pest for a number of years, it was advocated that no beans should be grown between mid-November and mid-March. Some such recommendation may be found advisable in infested areas here.

The recommendation has been made to earth up the plants, in order to encourage them to throw out new roots above the infested parts. It might also have the effect of trapping some of the adult flies when they emerge. It is recorded that a mulch, e.g. of rice straw, has been helpful in keeping the fly away from young plants.

Immediately plants are seen to be too diseased to mature, they should be taken up and destroyed by burning. This should also be done with the remainder of the plants immediately after harvest.

The application of insecticides in other countries has met with comparatively little success. On the other hand, in the review of an article published in Ceylon [7] it is stated that "Preliminary experiments against the various stages of *Agromyza phaseoli* on beans showed that a tobacco spray applied daily for ten days after germination reduces the severity of the attack to such an extent that the plants, especially those on manured plots, are able to produce good crops."

In order that any measures may prove successful, it may be found that the interest and concerted action of all planters in any one locality are necessary; and where the fly is a serious pest, these should not be difficult to obtain.

Several parasites of the pupæ are known; one found in Tanganyika will be identified. On the advice of Mr. F. B. Notley, Entomologist at Lyamungu, bean seed will be sown at monthly intervals for a year in order that the incidence of the pest, the number of generations, and the effect of successive crops on the parasite population may be observed.

In Ceylon [8] experiments with beans and cowpeas have indicated that although no variety was completely immune from attack by the bean fly, the degree of resistance varied considerably.

Finally, it should be stated that while the status of the pest in East Africa as a whole is not yet defined, its record elsewhere, and the evidence in parts of Tanganyika and Kenya, justify its being given serious attention. It will be realized that any local information on the pest that can be given by planters to their local agricultural officers for transmission to the specialist staffs of the Departments of Agriculture will be very helpful.

It would be appropriate to refer here to literature on the subject of bean culture, marketing, etc. (see References [6] and [9]).

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MARKETING ASPECTS OF DERRIS AND OF ITS CHIEF COMPETITOR, CUBE ROOT

We reprint below an article by Mr. C. D. V. Georgi, Senior Chemist of the Department of Agriculture, Malaya, which appeared in the Malayan Agricultural Journal *for January,* 1939, *under the title, "The Outlook for Malayan Derris in the United States of America." It contains information that will be of value to East African planters who have been considering derris as a new cash crop of promise.*—ED.

INTRODUCTORY

A large amount of selection work on derris has been carried out in recent years by the Department with the object of developing strains of plants with roots of a high toxic content, thereby eliminating to a large extent the variability in quality of commercial consignments of root.

The work has been attended with a certain amount of success, strains of plants of *Derris elliptica*, Changi No. 3, having been isolated in which the rotenone content, calculated on a moisture-free basis, is of the order of 12 per cent. The figure for the ether extract on a similar basis lies between 25 and 30 per cent.

In the early part of last year when the writer proceeded on long leave, permission was granted him to travel via America to discuss the results of this selection work with officers of the United States Department of Agriculture and with representatives of insecticide firms in New York. At the same time, opportunity was taken to collect information regarding the position of derris in relation to the other plant insecticide with which it competes, namely cube.

The present paper is a summary of a detailed report already submitted to Government. Mention is made, however, of the organization recently established in the United Kingdom for co-ordinating the results of research work on insecticide materials of vegetable origin being carried out in various parts of the British Empire.

SOURCES OF SUPPLY OF CUBE ROOT

Cube (pronounced "koobay") is the trade term applied to roots of various species of the genus *Lonchocarpus*, which is found widely distributed in the tropical parts of South and Central America.

Similarly to derris in Malaya, cube has been used from time immemorial by the South American Indians for fishing purposes. Plants were grown clandestinely, their cultivation in certain areas being prohibited by law owing to the detrimental effect of an increasing use of the root on the fish population of the rivers.

The discovery by Clark [1] of rotenone in cube root drew the attention of the insecticide manufacturers to the potential value of this root as a further source of supply of raw material.

The possibility of establishing a new industry also caused a change in the official attitude, campaigns being started to interest cultivators in this crop. These campaigns were highly successful, large areas both in Brazil and Peru having been planted in recent years. In this connexion it may be mentioned that in Peru the cultivation and industrial exploitation of plants belonging to the genus *Lonchocarpus* has been declared by Presidential Decree to be of public utility.

At the present time Brazil is the principal country of export, being followed by Peru. Smaller quantities of the roots are exported from Venezuela and Colombia, while it is understood that if there is a

marked increase in the use of cube, Nicaragua is considering the possibility of developing a local industry.

It may be of interest to record that, while cube is the trade term, the root is known as *timbo* in Brazil, *barbasco* in Peru and *haiari* in British Guiana.

Similarly to derris, wide variations have been found in the toxic contents of the roots of the various species of *Lonchocarpus*. With the objects of developing strains of high quality plants and reducing such variation to a minimum, selection work on similar lines to that being carried out on derris by this Department has been initiated in Peru.

Stringent regulations having for their object the prevention of the export of viable material are a feature of the cube industry at present. For example, in Peru, the export of *lonchocarpus* cuttings is prohibited. Further, with the object of preventing even the root from being used as a source of supply of planting material, all root exported must be despatched in an air-dry state, say 8 to 10 per cent moisture. In Brazil, the export of whole root, even though dried, is only allowed by special permit, the bulk of the root being shipped in a ground state. Such root is referred to in the returns issued by the United States Department of Commerce as "Root, advanced in value." Root imported into the United States in this condition is subject to a 10 per cent *ad valorem* duty. This duty would also be applicable to ground derris root.

Two reasons are adduced for these stringent precautions: the possibility of a vast increase in the cube industry if means are found to replace arsenical insecticides by plant insecticides of this type, and the prevention of the establishment of a major agricultural industry in other parts of the world on plantation lines, such as occurred in the case of the plantation rubber industry.

While it is not suggested that the plant insecticide industry will ever rival the plantation rubber industry in importance, there is no doubt that if this replacement is successfully accomplished the cube industry in Brazil and Peru will become of major importance and will doubtless be closely guarded, having regard to the nationalistic tendency prevailing throughout the world at the present time.

Trade in Derris and Cube Roots

Table I gives the amounts of derris and cube roots, together with their countries of origin and declared values, imported into the United States during the years 1936, 1937 and the first half of 1938.

Small amounts of roots in transhipment from other countries to the United States have been omitted from the table; they do not affect the figures to any appreciable extent.

The figures show a steadily growing popularity of cube compared with derris. Thus during the years 1936 and 1937 between three and four pounds of cube were imported for every pound of derris, but during the first half of 1938 this amount of cube rose to more than seven pounds.

The steadily increasing proportion of ground cube root compared with the total amount imported is noticeable. Thus in 1936 the proportion was 61.5 per cent, increasing in 1937 to 68.7 per cent, and in the first half of 1938 to 84.1 per cent.

With regard to the figures for derris, the decreasing exports from the Philippine Islands and the gradually increasing exports from Netherlands Indies are of interest. In the case of the Philippine Islands product it was stated that the decreasing importance of the trade was to a large extent due to marked variability in quality of the root.

TABLE I

IMPORTS OF DERRIS AND CUBE ROOTS INTO THE UNITED STATES FOR 1936, 1937 AND FIRST HALF OF 1938

Description of Root	Country of Origin	1936		1937		1938 (January to June)	
		Amount	Value	Amount	Value	Amount	Value
		Lb.	$	*Lb.*	$	*Lb.*	$
Derris, Crude	Malaya	332,251	69,182	401,975	72,613	122,746	16,480
	Netherlands Indies	28,581	5,145	57,524	10,609	62,710	8,797
	Philippine Islands	149,505	21,626	110,528	14,046	19,497	2,640
	Other Sources ..	—	—	368	74	—	—
	Total ..	510,337	95,953	570,395	97,342	204,953	27,917
Cube, Crude	Brazil	508,570	34,044	197,892	16,677	25,744	1,476
	Peru	171,600	19,350	378,259	34,487	213,444	14,075
	Venezuela ..	22,750	1,775	—	—	—	—
	Colombia ..	1,200	156	—	—	—	—
	Total ..	704,120	55,325	576,151	51,164	239,188	15,551
Cube, Advanced in Value	Brazil	1,124,936	172,239	1,263,773	190,844	1,268,337	181,439
Cube ..	GRAND TOTAL ..	1,829,056	227,564	1,839,924	242,008	1,507,525	196,990

QUALITY OF PRODUCTS

Importers are still complaining of the variation in quality of Malayan derris. Consignments of root guaranteed to contain a minimum of say 5 per cent rotenone are found to be deficient on analysis. The sample for analysis is drawn not from the bales of root but from the powder resulting from the grinding of a proportion of the bales, say 10 per cent, taken at random from the consignment. Sampling errors are thereby reduced to a minimum.

Two explanations suggest themselves for this somewhat disturbing contention. It is more than likely that with the high prices prevailing a few years ago for derris cuttings on account of the greatly increased planted area and the cultivators' lack of knowledge regarding proven material, some of the newly opened areas were planted with cuttings from stock poor in rotenone, for example *D. malaccensis* plants from the Kinta District, or even low-grade *D. elliptica* plants, of which there is ample evidence of being established in various parts of the country.

From the point of view of the native cultivator, rotenone is a comparatively recent introduction as a factor of importance in disposing of a crop of derris. It may well be, therefore, that unless such a cultivator has taken the trouble to verify the origin of his stock, the rotenone content may vary widely from generation to generation. It will be dependent to a large extent on that of the strongest growing plants, since it is from such plants that a cultivator is likely to select his cuttings.

It is also felt that the absence to date of a definite correlation between quality of root and price may be a contributory cause of this variation. For example, cases

have occurred in which dealers who have sold root on a 5 per cent rotenone basis, have suffered a deduction in price because the rotenone content on sampling and analysis has been found to be less than the amount specified, but they have not received a corresponding premium when the rotenone content of the consignment is in excess of the contract. Such a procedure is always calculated to induce the dealer to scale down his product to the minimum and to take a chance that the deficiency, if any, will not be discovered.

The remedy lies, therefore, in ensuring that both estates and small producers plant only material of proved high toxic content and propagate further stocks from that material alone. In the case of the small producer, a buying organization dealing only in such high quality root would also be necessary to ensure his receiving a fair price for his product.

With increasing quantities of high quality root coming forward, the industry will be in a much stronger position to insist upon the establishment of a price basis in which quality of root would receive its just reward. With the changed conditions the possibility of derris root of low and even moderate toxic content, for example, *D. malaccensis* from the Kinta District, being used only as a diluent or actually becoming unsaleable, unless such root was found to be a specific against a certain insect, must not be overlooked. The use of the root as a diluent will be referred to later.

As regards cube root, Brazil and Peru both appear to have profited by the experience of Malaya in this respect and to have paid considerable attention to the question of the maintenance of a standard quality of product.

Brazilian powdered root is said to average about 5 per cent rotenone with a total of 22 per cent ether extract. It is understood that this is not a whole ground root but a seived product from which the fibrous portion of the whole root is excluded. Since the fibrous portion is low in toxic content the sieved product will be higher both in rotenone and ether extract than the whole root.

The powdered root is packed in sealed barrels or cases, and each consignment is accompanied by a certificate of analysis.

It would appear that the milling of cube root in Brazil is practically a monopoly. This, together with the fact that the root is powdered, thereby making blending of material a comparatively simple process, facilitates the shipment of a uniform product.

At present only whole root is exported from Peru. There are two grades, the higher quality averaging 5 per cent rotenone with 16 per cent total ether extract and the lower grade 5 per cent rotenone with 14 per cent total ether extract. Attention has been drawn previously to the selection work initiated in Peru with the object of isolating plants with roots of high toxic content for propagating purposes.

It is interesting to note that all cube root from Peru is exported via the River Amazon and Brazil, the Andes forming a barrier to the export of the material from the western seaboard of that country.

The general impression is that with any marked increase in the use of cube, mills will be erected in Peru, thus bringing that country into line with Brazil.

Derris and Cube as Insecticides

The New York insecticide manufacturers are still inclined to regard rotenone as the criterion of insecticidal value, the ether extract being considered of somewhat secondary importance.

This seems to be due to the fact that in the control of the three major agricultural

pests against which both derris and cube are used, the pea aphid, the Mexican bean beetle, and three species of cabbage worms, the rate of application has been standardized on a rotenone basis. Further, both laboratory and field tests have shown cube to be equally effective as derris of the same rotenone content.

This view is not taken by the Food and Drug Administration of the Department of Agriculture, who regard the ether extract as of primary importance. For example, they require only the total amount of either derris or cube resins, that is the total amount of ether extract, to be entered on the label of a derris or cube insecticide for sale.

A specimen of an acceptable label is as follows:—

	Per cent
Active Ingredient—	
Derris resins	—
Inert Ingredients	—
Total ...	100.00

The rotenone content may, however, be entered on the label. Such a practice is optional. In such cases the label would read:—

	Per cent
Active Ingredients—	
Rotenone	—
Other Cube resins	—
Inert Ingredients	—
Total ...	100.00

The question of the relative toxicities of rotenone and ether extractives other than rotenone is still unsettled. There is a feeling that the ether extractives other than rotenone in derris are either more toxic or more repellant than those in cube, but there is no scientific evidence to support it. The general opinion is that a definite statement regarding the relative toxicities of derris and cube must be postponed until the results of tests with accurately analysed samples of the same particle size against a number of species of insects are available.

The analytical aspect is stressed because if rotenone is such a strong insecticide compared with other ether extractives, it is essential to determine the percentage with a high degree of accuracy, also to be able to separate it completely from the other extractives, thereby allowing a fair comparison of insecticidal values to be made. At present, the method for the estimation of rotenone, more particularly in derris root, is not characterized by the high degree of accuracy usually associated with quantitative analysis. Workers in various countries are actively engaged in endeavouring to improve the method and to arrive eventually at a standard method to be used when assaying the root.

As far as could be ascertained, this difficulty of complete separation of rotenone from the other extractives does not arise to the same extent in the case of cube root.

Similarly, the particle size must be emphasized. It is stated that the derris powder milled in the United States is of a finer particle size than the powdered cube root imported from Brazil, in which case the apparent superiority of derris over cube root towards a certain insect may be due to this cause.

Prices of Derris and Cube

The present preference shown for cube is due to the fact that it is offered at a lower price than derris of the same rotenone content. Cube is therefore the more economical insecticide to use against those major agricultural pests to which reference has already been made.

At the time of the writer's visit to New York (April, 1938) the current prices for root of 5 per cent rotenone content were about 14 cents for derris and 10 cents for cube (United States currency). For ground root of the same quality and ready for use as an agricultural dust the prices were 39 cents for derris and 28 cents for cube. Between 130 and 140 lb. of ground cube could therefore be purchased for the price of 100 lb. of derris of the same rotenone content. This represents a considerable saving to the farmer, especially during the present recession.

Further, the general opinion was held that with increasing supplies of both derris and cube coming forward prices would tend to fall, also the price advantage in favour of cube would tend to diminish.

This all-important price difference is the only factor opposing the use of derris in the United States. More than one insecticide manufacturer assured the writer that if only Malayan derris were available at a price with which it could compete with cube they would prefer to use derris. They considered that Malayan exporters, by seeking too high a price for their product in recent years, had tended to stimulate the production of cube.

The opinion expressed regarding a fall in price of the whole root and a diminution in the price advantage in favour of cube has been confirmed. Reference to the *Malayan Agricultural Journal* for December, 1938, shows that the latest price for derris root of 5 per cent rotenone content, c.i.f. New York, is about 11 cents per lb., that for cube root of the same rotenone content being about 8.5 cents per lb.

With regard to cube, it would appear that this is now liable to royalties under the Dennis patent amounting to rather less than 1 cent per lb., bringing the total cost of this root up to approximately 9.5 cents per lb., c.i.f. New York.

The Dennis patent refers to a patent granted in the United States in 1927 to Mr. W. J. Dennis, who obtained exclusive privileges to the use of ground cube root with the fibrous element removed as an insecticide and vermifuge.

The admissibility of the patent on certain technical grounds was challenged by some of the insecticide manufacturers but apparently the original patent has been upheld by the Courts.

Further, with the fall in price of both commodities, the price advantage in favour of ground cube root has diminished, there being only a 4-cent spread between the price at which derris and cube powders are offered compared with one of 11 cents as mentioned above.

No mention has been made of the price of root sold on the basis of ether extract, for example, *D. malaccensis* from the Kinta District. At present there is only a small demand for such root, which is used for mixing with root rich in rotenone to give a blend as required for a certain purpose. The solvent extract from this root, mixed with pyrethrum extract, is also used to some extent in the preparation of sprays against household insects, for example, flies and gnats.

In April, 1938, the current price for derris root of 18 per cent ether extract was about 10 cents per lb., c.i.f. New York, compared with 14 cents per lb. for root sold on a 5 per cent rotenone basis. Since that date the price of this root has declined to about 7 to 8 cents per lb., this figure being somewhat nominal.

Derris Elliptica, Changi No. 3, Root

All parties were particularly interested in the results of our selection work with the above type, and were surprised to

learn of the high rotenone content of the roots of some of our clonal material. As stated previously, the toxic content figures are of the order of 12 per cent rotenone and 25 to 30 per cent ether extract, calculated on a moisture-free basis.

At present, it is extremely doubtful whether a market exists for such a high quality root at a price commensurate with its toxic content based on either rotenone or ether extract.

The bulk of the derris and cube root as imported is used in the form of dust, being diluted with the requisite amount of inert material, for example talc or clay, to a definite rotenone content, say 0.75 per cent. For such purposes a high rotenone content is rather a disadvantage. In the first place much more of the diluent is required. Thus, assume that a finished dust containing 0.75 per cent rotenone is required. With a ground root of 5 per cent rotenone content approximately 600 lb. of the diluent would be necessary for each 100 lb. of powder, but with ground root containing 12 per cent rotenone no less than 1,500 lb. of diluent would be required.

Secondly, the more diluent that is added the more thorough must be the mixing to ensure an even distribution of the powder throughout the mass. This applies more particularly to the farmer or market gardener who may carry out the mixing of the powdered root and diluent himself on a cement floor, using only a shovel or other similar implement.

Thirdly, even with satisfactory mixing, there is a smaller chance of a direct hit on an insect owing to the smaller number of toxic particles in the mass.

Fourthly, in the case of the high quality root, mixing would have to be carried out close to the place where the insecticide was required. It would be uneconomic to pay heavy freight charges payable on insecticide containing such a large proportion of inert material which itself would be transportable in bulk at much lower rates.

Although the disadvantage of diluting with such a large amount of inert material might be avoided by a preliminary blending with root of low quality, for example, *D. malaccensis* from the Kinta District, to the present standard, this presumes a large supply of low quality root to be used merely as a diluent and for which manufacturers would only be prepared to pay accordingly.

The cultivation of two distinct qualities of root would be most unsatisfactory from the point of view of general agricultural practice; it is extremely unlikely that support for the low quality root would be forthcoming; in fact, it would be contrary to the best interests of the industry.

Under such conditions it would appear preferable to consider the development of another type, *D. elliptica,* Sarawak creeping, which is characterized by a remarkably high yield of root combined with a moderate toxic content, rotenone 6 per cent and ether extract 18 to 20 per cent. It is understood that such root would be most acceptable to insecticide manufacturers for use in the preparation of a dust.

As far as could be ascertained, the real future of high grade root, such as *D. elliptica,* Changi No. 3, lies either in the preparation of impregnated dusts or oil emulsions. In the case of impregnated dusts, the powdered root would be solvent extracted and the extract mixed with the inert material, possibly exhausted or partially exhausted ground root from a previous extraction. Evaporation of the solvent would leave an impregnated dust. An oil emulsion would be prepared by making a solvent extract and after evaporation of the solvent suspending the residual resins in a mineral oil by means of a stabilizer.

There is one serious drawback to the use of a vegetable insecticide, such as derris or cube, namely the comparatively rapid deterioration in toxicity of the material when exposed to light and air. The research staffs of various organizations are working on the problem of the addition of anti-oxidants or preservatives to insecticidal preparations having derris and cube as a basis, with the object of inhibiting this deterioration. It will be realized that if a successful preservative is discovered a much wider field for these insecticides will be opened. It may then, for example, be possible to use them against the codling moth on apples to the exclusion of arsenical preparations.

Inquiries were made regarding the possibility of extracting only the rotenone from *D. elliptica,* Changi No. 3, root and marketing it as such. There is, however, practically no demand for pure rotenone as an insecticide. As far as could be ascertained, its sole application had been in moth-proofing materials, such as fur coats and carpets, the rotenone being dissolved in a solvent, for example, ethylene dichloride, and the material sprayed with the solution.

In view of the overloaded and falling state of the market, manufacturers were unwilling to commit themselves as regards the price which such high quality root as *D. elliptica,* Changi No. 3, might be expected to command compared with root of 5 per cent rotenone content. A tentative suggestion was one cent for each additional per cent of rotenone over 5 per cent. Assuming the present price of derris of 5 per cent rotenone content to be 11 cents per lb., *D. elliptica,* Changi No. 3, root with 12 per cent rotenone would be worth about 18 cents per lb. Other manufacturers said that, assuming the present method of applying derris dust to continue, the price would be too high compared with the standard product. If, however, a demand arose for high quality root, either for impregnated dusts or oil emulsions, there might well be such a price spread between the two qualities, since solvent extraction would only be an economic process for the high quality root.

Discussion on Results of Investigation

The present prospects for Malayan derris in the United States cannot be considered bright.

While the product is popular as an insecticide, severe competition with cube has reduced the price to such an extent that little or no profit is left for the cultivator. The present price of 11 cents per lb., c.i.f. New York, after allowing say 4 cents per lb. for freight from Malaya to United States, corresponds to approximately $17 per picul (Straits currency) for root delivered in Singapore.

The future trend of the market is also difficult to foresee. It depends upon whether supplies of cube are maintained at the present low price, also whether fresh applications for both derris and cube are discovered, particularly for material rich in rotenone. If the bulk of both products continues to be used as dust it is possible that a medium quality root, such as *D. elliptica,* Sarawak creeping, with its high yield of root, may be the most suitable for general cultivation. Much depends, however, on whether a strain of *D. elliptica,* Changi No. 3, can be evolved in which high yield of root can be correlated with high toxic content.

In view of the present low price of derris and the high proportion which the shipping charges bear to the price of the root, inquiries were made as to whether Malaya would be better advised to consider the possibility of grinding the root locally and exporting the powder, thereby

following the example of Brazil with cube root. Although such a procedure would result in a reduction of shipping charges, there are certain disadvantages; for example, the cost of machinery, the health hazard, and the *ad valorem* tax on entry into the United States.

Laboratory experience has shown that it is much more difficult to reduce derris root to a powder than cube root, the latter being of a soft spongy nature compared with the hard fibrous derris root [2]. This view is confirmed by New York importers who state that the machinery required for the efficient grinding of derris root is both intricate and expensive. For example, the latest type percussion mills, which are used for this purpose, are water-cooled to prevent the material from becoming too hot, thereby avoiding the possibility of any decomposition in the resins. It has been found that if the material heats too much during the grinding there is a decrease in the rotenone content. This confirms results obtained in this laboratory some years ago when it was found that if powdered root were dried in a vacuum oven at 80° C. before analysis, a lower rotenone content was found than if air-dry powder were used.

One of the latest type percussion mills may cost as much as $25,000 (United States currency). In view therefore of the high cost of machinery, it is more than probable that a central organization would have to be formed to carry out the grinding of the root and the blending of the product. It would undoubtedly be more economical in the long run to have one large mill working continuously and maintaining a standard product rather than a number of small mills running intermittently.

The health hazard is considered somewhat serious in the United States. Particular care is taken to maintain all parts of the mill in an airtight condition to avoid throat affections of the workers owing to the fine dust floating in the atmosphere.

The 10 per cent *ad valorem* tax has been mentioned previously.

Although the export of ground derris root would affect some of the American importers who have installed special mills for this purpose, there seems little doubt that it is inopportune principally on account of expense and uncertainty regarding the future trend of the market, to suggest such a radical change in the mode of packing and shipment. It would appear preferable for the present to endeavour to raise the quality of the root by planting only selected material, thereby eliminating to a large extent the present variability.

Shipping charges may also be reduced by chopping the root into short lengths before baling. This enables a much greater weight of root to be compressed into a bale of given dimensions; for example, in a bale of 42 in. x 30 in. x 28 in., 240 lb. of chopped root can be packed compared with 175 lb. of whole root. Attention has been drawn in a previous number of this journal to the question of baling chopped root [3].

Research Work on Vegetable Insecticides in the United Kingdom

On his return to England the writer was invited to attend a meeting of the Imperial Institute Consultative Committee on Insecticidal Materials of Vegetable Origin to give an account of his visit. This Committee is part of the organization recently established in the United Kingdom for dealing with the question of these insecticides.

A brief summary of the developments to date is as follows:

At a meeting held in July, 1937, at the Colonial Office, the Colonial Advisory Council of Agriculture and Animal

Health decided that, in view of the growing importance of vegetable insecticides, co-ordination was essential between the organizations engaged in research work in connexion with such products. The organizations are:—

(*a*) Imperial Institute.

(*b*) Rothamsted Experimental Station.

(*c*) Department of Agriculture, Straits Settlements and Federated Malay States.

(*d*) East African Agricultural Research Station, Amani, Tanganyika Territory.

(*e*) Department of Agriculture, British Guiana.

The Council also considered that the work already in progress at the Rothamsted Experimental Station should be extended by the recruiting of additional staff, grants to meet the necessary expenditure being obtained from the United Kingdom Development Fund and the Colonial Development Fund.

An organic chemist and an entomologist have been recruited and a three-year programme of work laid down. It was decided to concentrate work on the rotenone (and allied substances) content of vegetable insecticides, notably derris. The main lines on which investigations are proceeding are as follows:—

(*a*) The various analytical methods for determining rotenone with a view to arriving at some method which could be accepted as a standard and which would give uniform results in the hands of all workers.

(*b*) The other toxic materials which occur in derris with the object of throwing some light on the toxic substances which occur as precursors of toxicarol, deguelin and other compounds which have been isolated from derris.

(*c*) The devising and standardization of satisfactory biological methods for testing the toxicity of insecticides such as derris.

Arrangements have also been made whereby the results obtained are made available to workers of the other organizations engaged on research on the same lines.

The writer attended a meeting at the Imperial Institute to discuss the question of the adoption of a standard method for the determination of rotenone, while he also visited the Rothamsted Experimental Station in connexion with work on this subject.

In addition, as indicated above, the Imperial Institute has set up a Consultative Committee on vegetable insecticides, one of the functions of which is to maintain touch with the commercial interests involved with a view to providing reliable information concerning the future supply and demand for such materials.

A monograph on the subject of insecticidal material of vegetable origin is in course of preparation by the Committee, who also issue a quarterly bibliography of all literature on this subject.

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THE POSSIBILITIES OF VEGETATIVE PROPAGATION OF COFFEE

The following article by Mr. W. Wilson Mayne, Senior Coffee Officer at the Mysore Experiment Station at Balehonnur, was written with special reference to conditions in the coffee districts of Southern India. It is reprinted, with slight curtailment, from The Planters' Chronicle, *Dec.,* 1938.

There are commonly three ways in which a tree or bush crop may be established over a given area. It may be raised from seed or from cuttings or by grafts made either on seedling stock, or stocks raised from cuttings. The practice in coffee cultivation is always the first method, but there are certain very great advantages in the other two methods, and in practically every coffee producing country a great deal of attention is being paid to the problem of vegetative propagation of coffee both by cuttings and by grafts. The present article is an attempt to outline the possibilities of these methods in relation to coffee production. It is not intended to be an account of the technique of grafting or other methods of vegetative propagation of coffee beyond what may be necessary to make clear its bearing on practical estate problems.

In the first place, it is desirable to make quite clear what these methods of vegetative propagation mean. Propagation by cuttings involves the establishment of a complete plant from some isolated portion of another plant—either a piece of root, shoot or leaf which under suitable conditions is induced to regenerate the missing parts. Propagation by grafting involves the insertion of a piece of one plant into another plant under conditions which permit the inserted piece (the scion) to form a living fusion with the other plant (the stock). The stock may be raised from seed or a rooted cutting. From the point of view of the present discussion, budding and grafting may be regarded as identical.

The first question to be considered is what are the advantages to be gained from these apparently cumbersome methods of reproduction over those obtained from the usual easy methods of seedling plants. The principal disadvantage of seedlings is their lack of uniformity. This is easily shown by the inspection of any area of plants raised from seed. The process of seed production involves the bringing together of different characters and their reassortment so that the seed plants may differ among themselves and from their parents according to the way in which various characters are assembled in each plant. These characters involve every feature of the plant—productivity, fruit characters, leaf characters, disease resistance, and so forth—so that many different types may arise from seed from the same parent plant. Of course, it is possible in theory, and sometimes in practice, to establish families of plants which breed true, but the process with a tree crop would take many generations even where it is theoretically possible.

On the other hand, a plant raised from a cutting is identical in its fundamental characters with the plant from which it originated, though it will be subject to minor variations induced by environmental differences. In the case of a graft made on a seedling stock, the possibilities of variability are greater, but the fundamental characters remain and a much greater uniformity may be expected than from seedling plants. Thus, in apples, a Bramley's Seedling may be grafted on a

dwarfing stock or a vigorous stock, and the resulting trees will differ greatly in their development. At the same time it appears that such variations are not more than can be accounted for by changes in vigour. Gardner, Bradford and Hooker in *Fundamentals of Fruit Production,* dealing with this question, state: "None of these influences (i.e. of stock on scion) differs from effects that might be secured from so manipulating cultural conditions as to modify vigour." With suitable selection of stock, a very high degree of uniformity can be obtained even on seedling grafts where the scions all come from the same parent type.

The primary advantage of vegetative propagation is therefore a gain in uniformity. In addition, grafting in particular may be of great advantage in the reproduction of types which grow poorly on their own roots or which are subject to various soil parasites to which other types are resistant. The last advantage is well illustrated in the case of grapes susceptible to Phylloxera, which can be cultivated in infested areas only on stock which do not suffer attacks by this serious pest.

It can be seen at once that vegetative propagation offers a means of increasing the uniformity of an area under a tree or bush crop, of multiplying valuable strains or varieties which do not breed true when propagated by seed, and of permitting the cultivation of valuable strains which do poorly on their own roots, either on account of deficiencies of vigour or of susceptibility to root parasites to which other strains are resistant.

Numerous articles have appeared on the methods of vegetative propagation applicable to coffee, but comparatively little has been written on the place that such methods may be expected to play in coffee production. It is now reasonably well established that coffee can be grafted with a fair degree of success, and although so far propagation by cuttings has not passed the experimental stage it seems that it only awaits the discovery of the right conditions for high percentages of success. There is therefore a need for an examination of what may be expected from vegetative propagation from a practical point of view.

There are two aspects of the question. On the one hand there is an indirect possibility of usefulness to the industry through its use in the solution of technical problems. On the other, there are the possibilities of the direct utilization of such methods on the estate. Both of these aspects must be considered, as they are both of importance to the industry.

In the first place, it must be admitted that the vegetative propagation of coffee is greatly handicapped by certain peculiarities of the coffee plant. If, from a graft or a cutting of coffee, a tree type of plant is required then the scion or the cutting must be taken from a vertical shoot. Grafts have been made successfully with scions taken from primaries or secondaries, but such grafts never send up a true vertical shoot and remain as low bushes. The necessity of taking scions from vertical shoots if a normal type of tree is to be obtained means that the number of scions that can be taken from any one plant in a season is very restricted. With the very large number of trees per acre in Southern India the provision of scions for the grafting of any substantial area would present very serious difficulties. Any consideration of coffee grafting must bear this important fact in mind.

Although an improvement in uniformity of the coffee in a great number of estates might well be of very great advantage, it seems very unlikely that this could be achieved by grafting without very great expense both of time and

money. With 1,200 to 1,700 trees per acre and in view of the problems of the supply of scions, it cannot be regarded as a practical proposition. From an estate point of view, improved uniformity of the product must be sought in some other way. There are, however, several other ways in which grafting may find a restricted use on the ordinary coffee estate.

An inspection of almost any coffee estate will show the presence of scattered plants of great vigour and disease resistance, probably of hybrid origin, which are useless as productive units. Grafting offers a means of making use of such plants, by permitting the development of a more productive head on the existing root system. Such plants can be stumped and a sucker allowed to develop. On this sucker the scion of a more productive type can be grafted. An exactly similar procedure can be applied to the scattered robusta plants which are almost as common a feature in South Indian estates, and which have to be harvested separately from the rest of the coffee. This procedure has been used with success at the Experiment Station and also on one private estate.

Secondly, many estates have outstanding plants which are promising seed bearers. The multiplication of such plants by grafting affords a valuable means of increasing the seed production of a given good plant. This is well worth the attention of those who are regular producers of seed coffee, with a view to building up separate seed producing blocks of single plant origin. Such good plants could also be used as scion producers for working over the odd hybrid or robusta plant referred to above.

There are some possibilities that grafting might be useful in dealing with the eelworm problem, since robusta appears not to suffer severely from this pest in infested areas. Unfortunately, however, such areas are on such a large scale in the affected estates that it will only be occasionally that this method can be adopted. The only solution for such areas appears to be the transfer to the production of robusta coffee.

At present therefore it seems that the usefulness of grafting on the ordinary estate is limited to removing the more obviously off type trees, such as hybrids of poor productive value and individual robusta plants in arabica areas, to the more rapid multiplication of good potential seed bearers, and possibly in some cases to deal with a soil pest problem.

The indirect usefulness of a reliable technique of vegetative propagation to the coffee industry is very great in two main directions. In the first place, it has been found from bitter experience that the layout and conduct of field experiments with coffee presents enormous difficulties and that the primary cause of these difficulties is undoubtedly the very high variability of the plants in any block of mature coffee selected for experimental work. If areas can be planted up with vegetatively propagated coffee, this factor of variability could be very greatly reduced. This would lead to a much greater accuracy of experimental work and also would permit a reduction in the size of the plots required for a given degree of accuracy. There are many pressing problems of the industry which can only be satisfactorily solved by field experiments, and any method which can facilitate such experiments represents a gain to the industry as a whole.

In the second place, vegetative propagation is a very valuable tool in the hands of the plant breeder. At the Experiment Station at Balehonnur there are a number of highly promising selected coffee plants which give good yields and show a very high degree of resistance to Leaf Disease.

Some of these plants have shown highly promising progeny, although the offspring do not all resemble the parent. The progeny that can be raised from a single mother plant are limited, but the number can be indefinitely increased by increasing the number of mother plants by vegetative propagation, since the vegetatively propagated plants are identical in constitution with the plant from which the scions or cuttings are taken.

If a certain selection is found to give a high proportion of good plants when self-fertilized, vegetative propagation affords a simple means of establishing an isolated seed garden, from which the seed can be regarded with a high degree of certainty as arising from self-fertilization. Plants raised from such seed could be expected to show similar proportions of good plants as would be obtained from the original mother plant, and of course the quantity of seed of this type would be greatly increased. The importance of this to the industry as a whole needs no emphasis.

This possibility has a bearing on future lines of development. If seed of an improved strain of coffee should become available in the next few years, it is unlikely that it will give completely uniform seedlings, even if the obvious weaklings are rogued in the nursery. The indications are that susceptibility to Leaf Disease is likely to be the most serious factor affecting productivity, but grafting offers the possibility of using such plants as stocks and grafting scions from resistant plants of the same family. For example, assuming that a supply of seed gives some 75 per cent type plants, the remainder differing in disease susceptibility. These latter could be readily identified in the first year or two and there would be no insuperable difficulty in grafting with scions from resistant trees, in the ordinary estate. This is, of course, not a matter of immediate usefulness, but it will serve to indicate that grafting in estate practice may be of increasing importance in the future, when improved strains begin to become available.

ALARMISM IN SOIL CONSERVATION

"The consideration of the whole circumstances over a period of time will tend to a proper discounting of the alarmist attitude in respect to land deterioration which at times recently has been in evidence. Let it be made quite clear that discounting the alarmist attitude is not the equivalent of denying that urgent attention should be given to land deterioration. Actually, the sooner land deterioration receives proper attention the better. But if an alarmist attitude prevails there is always danger of hasty action not founded upon proper knowledge.

"Our knowledge of how to deal in an economic manner with certain phases of land deterioration is far from complete. The proper foundation for any course of action lies in obtaining more complete knowledge. The position is complicated by the fact that in considering land utilization it at times becomes necessary to differentiate between what is economic to the State and what is economic to the individual. From this it follows that the most effective handling of land deterioration may at times necessitate State action along lines which would be impracticable to the individual."

—Mr. R. P. Connell, in *New Zealand Journ. of Agriculture*, 15th July, 1939.

THE USE OF LEVEL CONTOUR BANKS AND LIVE OR DEAD WASH STOPS IN EROSION CONTROL IN NATIVE AREAS

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The setting out of terrace banks and channels on a variable grade for erosion control requires previous planning of terrace outlets and points of discharge for run-off water, planning which is done more satisfactorily on the basis of the minor or major watershed rather than for the individual holding. The setting out of the pegs for the terrace lines is not done very easily without the aid of an engineer's level in the hands of a skilled operator. In consideration of these two facts the decision is often made that in the native reserves, financial circumstances and absence of trained staff necessitate the adoption of simpler methods. The methods must be such, it is said, as the natives can carry out themselves, or at least with a small amount of assistance by native instructors.

It may be decided therefore that erosion control must be brought about by means of simply constructed contour banks, hedges, lines of grass or other live vegetation, or dead material such as lines of maize or sorghum stalks. Provided the contour lines are set out accurately, and given that slope and soil are suitable under the rainfall intensities experienced, such methods may be effective, provided constant attention is paid to maintenance. There are, however, risks involved, which it is the purpose of this article to discuss.

Where the population is not heavy, and the demand for land is not intense, a long bush fallow adds to the humus content of the soil. A soil in good heart does not wash so readily as worn out and impoverished soil, so that a few simple measures such as live wash stops or lines of trash will probably suffice (unless the slope is very steep) during the three or four years for which the land is cultivated before being fallowed under bush and grass. On the other hand, very little improvement is seen from a bush fallow on land already eroded, while if the population is dense, the short period of the fallow and the fact that it is heavily grazed may result in continued deterioration of the soil even during the fallow period. This is likely to be particularly marked in the drier areas, where a reduction in fertility of the soil results in decided retrogression of the type of plant cover and a reduction in its completeness. In these circumstances, a large proportion of the rain water is likely to run off, causing heavy loss of soil. As the vicious circle continues, less and less confidence can be placed in methods for checking erosion that do not involve the planned disposal of surplus run-off. Since so many thousands of acres of arable land in East Africa are being protected by "simple" methods, some reflections on the limitations to their suitability will not be out of place.

A level bank or wash-stop has the intention of holding up *all* the run-off water and eroded silt. If the obstacle is made sufficiently high and strong no water will escape; the soil is presumed to be capable of soaking it all up. The silt which is held in the channels reduces their capacity and has to be cleared out periodically. If stone walls are made, they have to be raised continually or the excess of water will burst over later on, when the silt is level

with the top, and will cause gully erosion down the slope, the whole series of walls probably being breached.

The ultimate result of a series of level walls, banks or lines of live or dead vegetation will be therefore a series of level bench terraces, formed as a result of the movement of soil down the slope, a movement which will be accelerated by the custom of digging downhill. If the obstacles are spaced at too great horizontal intervals the drop from terrace to terrace will be great, perhaps as much as seven or eight feet, and there will be difficulty in preventing the edges of the banks from giving way under the tremendous weight of water-soaked soil above. If due attention is not paid to the maintenance of the banks at the terrace edges there will be a danger of breakages at weak spots, especially if the terraces are planted up with crops in rows not exactly on the contour; and breakage of the terrace banks usually means gullying of the slope through the whole terrace system.

In one African territory 5,000 acres were ruined in one block as the result of the failure of a level terrace system. In the southern United States many thousands of acres have become benched or partially benched by the use of bank terraces, or by the practice of leaving contour strips of untouched vegetation. The result is described in the following quotation:—[1]

"About this time" (1850-1860) "terracing came into more widespread use, especially in the southern Piedmont. Although some terraces had been built prior to the fifth decade, the practice was employed only rather ineffectively throughout the greater part of the nineteenth century. Terraces were crude and were often constructed in such a manner, placed on such steep erodible slopes, or so neglected, as to be more harmful than helpful. Built solely to reduce the rate of off-flowage from the land, the earlier terraces frequently were constructed with so much fall, often as much as 3 or 4 feet in 100, that water flowed with sufficient erosive force to cut through at the bends and other weaker parts of the embankments. Once they had broken, these narrow ridge terraces, so narrow that a man could step over one, served only to concentrate the water, causing gullying with each heavy rain. Since little attention was given to caring for water at terrace ends, gullies formed at these points.

"Little effort was expended in maintaining terraces. They often filled, and water flowed across them, descending over the accentuated slope on the downhill side in waterfall fashion and gouging out gullies. Thousands of fields have been abandoned entirely or in part, especially throughout the Piedmont of South Carolina and Georgia, because of gullies forming from neglected terraces. Reconnaissance erosion surveys indicate that at least two million acres of land in Georgia, all at one time terraced, have been abandoned to old-field pine. Some of the terraces in these old fields were well built on proper gradients; their failure was due either to neglect or to excessive steepness of the fields, or to both factors."

Even if terraces are maintained adequately, the soil may yet fail to absorb the whole of the rainfall so as to drain it away gently. On loess soils in China, failure of systems of level terraces to drain properly has resulted in accumulated water finding its way underground and hollowing out subterranean caverns which eventually cave in to form "sink-holes". As the sink-holes grow larger or coalesce they form gullies. Yet another evil to which bench-terraced land is liable on certain soils is that the terraces become waterlogged: the plants go yellow and the crops fail. This misfortune has been experienced in some parts of Africa.

It may be thought odd that excess water is considered likely to cause so much trouble on land laid out in level terraces. It must be remembered that many of the more severe slopes were under forest. The top inch of a forest soil is said to be able to absorb fifty times as much moisture as the top inch of soil on

1 "Soil Defense in the Piedmont," by E. M. Rowalt, 1937, U.S.D.A. Farmers' Bulletin, 1767.

agricultural land. The forest litter acts as a sponge which lets the water drain into the subsoil very gradually. Even where the cover did not consist of forest, a good cover of trees, bushes and grass must have had a similar, if modified, effect, and at worst the ground cover impeded the flow of excess water passing over the surface of the slope, so that little or no soil moved with it. When such a cover has been destroyed by cultivation—or has been replaced by heavily grazed and trampled grassland—the soil is no longer so absorbent and a problem arises in the disposal of surplus water.

The safeguard against waterlogging or sink-hole erosion is drainage. Channels on a variable grade can be placed just above the terrace edge, but there is some risk of breakage of the terrace by water soaking in and weakening the bank. Alternatively, the channel can be placed at the *foot* of the bank, the terrace below being given a slight tilt inwards, towards the hill. This can be done by continual ploughing downhill with a reversible plough followed by scraping with a grader or by hand. But if contour lines have been put in by numbers of independent but adjoining cultivators, there may be an uncorrelated set of bench terraces, the drainage of which presents an almost insoluble problem. In any planned scheme of soil conservation the drainage system is thought out beforehand and the terracing system is made to fit the lie of the land. Unco-ordinated efforts at erosion control by individual occupiers may lead, by contrast, to a chaotic situation in years to come, and may actually promote, instead of preventing, destruction of the land.

In view of these various difficulties about bench terraces, can the natives be expected to check soil erosion effectively on their fields by their own efforts? Where the soil is very absorbent, the rainfall medium and the slopes not too severe (above, say, ten per cent) this may be so if sufficient advice and supervision are available to ensure good construction and maintenance of the contour banks or walls, or lines of live or dead vegetation. If any factor is unfavourable, however, the result of attempts at erosion control by too-simple methods may be disastrous.

Before proceeding to discuss the use of various methods of building up level bench terraces—as by earth banks or stone walls—in situations where the method is safely applicable, it will be well to enumerate certain general principles. The horizontal distance apart of the contour must be such that the eventual height of any terrace or "step" in the slope is not more than two or three feet. A greater height than this will make it difficult to prevent the edges of the terraces from slipping and breaking. Further, the building up of a deep terrace will mean the denudation and virtual sterilization of the land above and the piling up of all the good soil near the bottom edge of the terrace.

As a general guide the following vertical intervals might be taken:—

Slope	*Vertical Interval of Contour Lines*
0 to 5 per cent	.. 1 ft.
5 to 10 per cent ..	.. 2 ft.
Over 10 per cent ..	.. 3 ft.

Thus on a 4 per cent slope the lines would be 25 feet apart and the terraces each one foot high; on an 8 per cent slope the lines would also be 25 feet apart but the terraces would not be level until they were two feet high; if the slope was 30 per cent the terraces would be only ten feet wide but they would be three feet high. The terracing should be so planned that, if found necessary later on, drainage can be provided into natural protected watercourses, or alternatively in such a way that artificial drainage channels can be cut readily.

If the edges of the terraces consist of bunds or stone walls, the tops of these should be maintained 18 inches above the level of the soil on the terrace above. Even if grass or some hedge plant is used to form the obstacle, it is not unlikely that it will also be found necessary for a bank to be maintained, or at least a substantial line of cut vegetation, sufficient to check the run-off and cause settlement of the silt to form the terrace. The earth bank or stone wall should have a slope inwards of 45 degrees; this is particularly important in the case of earth banks, which should, in addition, be protected by planting with grass, both on the outer edge and on the top. Needless to say, pernicious running grasses which are likely to become troublesome in the cultivated land should not be planted on the banks unless the hillside is to be maintained as permanent pasturage.

While the height of stone walls must be increased by further building as the silt accumulates, cleaning out the ditches at intervals should suffice to provide for the maintenance of the height of earth banks.

Earth Banks

There is also the kind of contour banking that is not intended to result in the formation of bench terraces, but is meant to leave the ground at its original general slope while providing obstacles to run-off water at regular intervals. For this purpose the earth banks should be made at least three feet wide on steep slopes, preferably six to ten feet wide on easier slopes not greater than 12 or 15 per cent, especially if some form of terracer is available; but large areas are better protected by banks with a variable grade at the standard vertical distances apart, unless the soil is porous and it is considered that the heaviest rain which is likely to fall can be absorbed safely. It is desirable in most districts for the banks to be protected by planting with grass for hay or with some fodder crop. Cultivation of the banks is likely to lead to their rapid destruction. Unfortunately, however, the presence of grass on the banks generally is unpopular with natives owing to the usual ingression of pernicious "couch" grasses.

Lines of Grass

The use of lines of long grass as an erosion control measure should properly be regarded as experimental in any area until local officers are satisfied as to its efficiency. In general, the grass lines will produce a benching effect; whether or not the preliminary benching through deposition of silt from the checked water will be followed by gullying and destruction of the field will depend on the nature of the soil, the size of the catchment area, and the intensity of the rainfall.

The grass lines must be substantial. It is essential for the clumps of grass to be planted not more than about a foot apart, and for a double row to be planted, so that the clumps in the second cover the spaces in the first.

Incidentally, care must be taken to ensure that the native farmers plant out the grass accurately along the line as pegged. Instances have been known of the native farmer, working with his back to the line of pegs, ending by planting his "contour" from one line of pegs across to the next.

When the grass line has been planted it must be maintained carefully and continuously. The grass plants often die out in patches, especially through drought or by fire, while grazing animals or careless cultivators may knock out part of the line. There are no means of keeping the soil on arable fields which do not demand constant vigilance; so the attempt should not be made to cover a larger area of native land than can be supervised

adequately with the European and native staff available. The grass must be cut periodically and laid along the top side of the clumps; similarly, dead stalks of maize, millet, sorghum, etc., so placed can be of help.

Observations should be made on the longevity of the grass plants used, the power of the grass to root afresh at a higher level as the old roots become buried by accretions of silt, and the effect of the grass on the growth of neighbouring crops. Elephant grass (*Pennisetum purpureum*) should prove suitable in the first two respects, but often has an ill effect on neighbouring crops for a distance of eight feet on either side. This would be serious on a slope the severity of which necessitated lines as close as twenty feet apart; there would be virtually no productive land left between the rows. This effect is not so marked in very moist districts, and competition between crop plants and this strongly rooting grass may be diminished if it is cut down whenever about four feet high, being allowed to grow tall only between seasons, when there are no crops on the land.

The Use of Dead Materials in Contour Lines

Where stalk-borer is not a major pest, stalks of maize, sorghums and millets may be used in contour lines, as wash-stops. Grass could be cut and used for the same purpose. It is important that the trash should be placed on the same contour lines each year; otherwise, instead of a system of level terraces being formed, there will be a progressive slight movement of soil downhill each season, the movement being checked at the new lines of trash. When a definite terrace edge has been formed it must be protected by planting grass. An ample "ledge" of dead stalks, grass, etc, must always be provided to prevent wash of soil over the terrace edge, and it may be wise to provide eventually an earth bank at the edge.

Hedges on the Contour

The use of plants such as *Coleus* sp., *Dracaena* sp., and *ojuok* (*Euphorbia tirucalli*)[1] as contour hedges is subject to the general principles that were suggested in the general section on level contours. Systematic employment of these and other hedge plants in soil conservation measures has, however, yet to be undertaken in Kenya, and it is impossible to make definite recommendations regarding their use.

Conclusion

Erosion control has the object, firstly, of promoting the absorption of as much as possible of the rain water and reducing the quantity and velocity of the run-off until it has no power to carry soil with it; secondly, if the quantity of run-off water is still considerable, it must be led slowly away along graded and protected channels to a point where it can do no damage.

A clear understanding of the conditions under which the simplest type of erosion control, consisting chiefly of inducing absorption, is applicable, and of the circumstances under which provision must additionally be made for the disposal of surplus run-off, will prevent mistakes in soil conservation technique which may ruin land and cause the forfeiture of native confidence and co-operation.

[1] Known as *manyara* in Tanganyika.—*Ed.*

NOTES ON THE USE OF THE STRIDING LEVEL WHEN LAYING OUT CONTOUR BANKS

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In the January (1939) number of this Journal there appeared a description of a striding level for use in laying out contour banks. The level, as originally designed by Wade, was intended for laying out level banks. This limits the length of the banks to two hundred feet, since banks of a greater length than this should be laid out on a falling or variable grade in order to reduce the danger of the banks breaking. The writer has been experimenting with one of these striding levels for the past six months, and strongly recommends its trial by anyone whose work brings him into contact with the construction of contour banks.

A modification of the original instrument has been introduced to enable the level to be used for the lay-out of banks having a variable grade. By superimposing metal shoes of varying thickness on one of the feet it is possible to lay out traces of variable grade with speed and accuracy. Probably the simplest method is to employ U-pieces of flat iron of varying thickness—say, $\frac{1}{8}$ in., $\frac{3}{16}$ in., and $\frac{1}{4}$ in. These would give readings of 1 : 960, 1 : 720, and 1 : 480 respectively. The writer has been experimenting with two shoes of $\frac{1}{8}$ in. flat iron, the second shoe being added to the first when desiring to increase the fall.

Experiments are also being performed with another device for use in conjunction with this type of level. This device has been designed to provide African instructors engaged on the construction of contour banks with a reasonably accurate means of measuring the slope of the ground, and thereby to provide them with a means of laying out successive banks at the optimum distance apart. It consists of a hardwood board 20 in. x 3 in. x $\frac{1}{4}$ in., which is marked off with lines at intervals of 1.2 in. from the bottom—since 1.2 in. represents 1 per cent of the length of the level. A $^{5}/_{16}$ in. hole is drilled below each line in such a way that it just touches the line. This offers a snug fit for the normal-sized copying pencil, which can be used as a peg. The operator, after selecting a site representative of the average slope of the ground, sets the striding level in direct line with the maximum slope. The board, with its peg in one of the holes, is now placed upright alongside the lower leg of the level. The leg is placed on the peg and the operator checks the "bubble" reading. If the bubble is not in the centre position he instructs his assistant to move the peg up or down until it rests in a hole which gives a correct reading. If this occurs at a point between two holes the upper hole is taken as being the correct one. The board is then removed with the peg still in position. The operator then knows, by reading the figure on the left-hand side of the peg, what is the slope of the ground. From the corresponding figure on the right-hand side of the peg, he obtains the required interval between the banks down this slope. When marking out a board for use by natives, it is simplest to divide the distances apart (in feet) by 10, i.e. to have the right-hand scale marked in direct multiples of the length of the striding level. This enables the operator to use the level itself for measuring distances from one bank to the next. Thus if he finds that the level reading occurs when the peg is in the fifth hole from the bottom of the board, he knows that the slope of the ground is approximately 5 per cent and that the next bank should be started at a point

6½ times the length of the level, or 65 feet away straight down the slope.

It might be argued that the correct spacing of the banks should be obtained by measuring the strictly horizontal interval instead of the distance down the slope. Any error that occurs up to slopes of 16 per cent is, however, so slight as to be of no importance. The distances apart given on the board described above represent the horizontal equivalents of the vertical heights given in Table 3 on page 57 of Bulletin No. 1 of 1935, issued by the Kenya Department of Agriculture.

With reference to the actual construction of the striding level, it has been found that it need be made of timber of no greater thickness than three-quarters of an inch. The main beam need not be of a depth greater than 3¾ in. at the centre and 2¾ in. at each end. At the same time it is advisable to screw on a narrow plank along the top of the beam in order to give it the necessary rigidity. This need not be more than ¾ in. in thickness and 3½ in. in breadth at the centre, tapering to a breadth of 2½ in. at each end. A metal wearing plate should be fixed to the foot of each leg. The metal shoe used to obtain the readings for a falling contour should rest firmly against the wearing plate of the leg to which it is attached—not as in the diagram of the level which was printed in the January number of this Journal.

Six months' experience with one of these striding levels has satisfied the writer that it is the ideal instrument for use by natives in charge of the lay-out of contour banks. It might not prove so effective on land which is covered with tussocks; but under all normal conditions it appears to serve its purpose excellently. It is very cheaply and easily constructed. Unlike the pendulum-pattern road tracers,

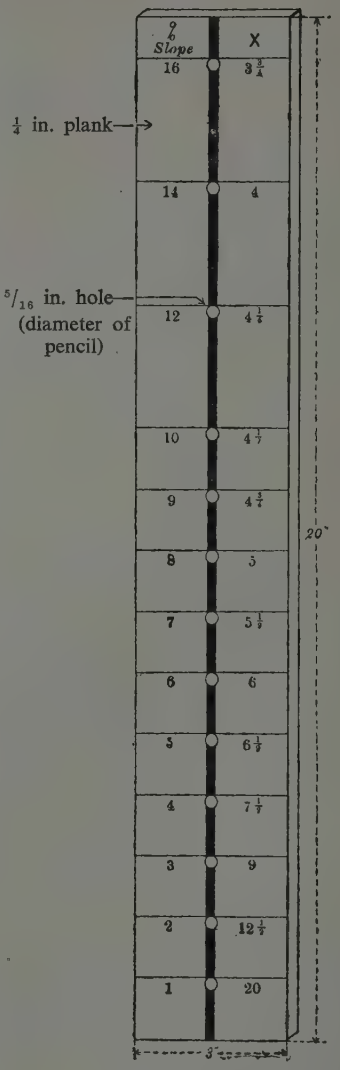


Diagram of attachment for use in conjunction with striding level in order to find degree of slope and correct distance apart for lay-out of contour banks.

it is unaffected by the wind. Proficiency in its use requires the minimum of instruction. It is impossible for the operator to take short cuts across major irregularities in the ground, as is liable to happen when natives are using a level, a road tracer or boning rods. It requires only an operator and one assistant provided with a hoe to mark out the trace of the contour. In the writer's opinion, it is an instrument worthy of trial by anyone whose duties entail the lay-out of contour banks, and he is convinced that it will prove of great assistance where anti-erosion work is being carried out under the supervision of African instructors.

The difficulty experienced in Tanganyika of obtaining well-seasoned wood is a disadvantage, since any tendency to warp will, to a certain extent, affect the accuracy of the instrument. The ideal material from which to construct such an instrument would be light tubular steel. It is thought that by means of an overlapping sleeve it would be very easy to arrange for the attachment for determining the slope to be embodied in the instrument itself.

CONSERVATION OF THE SOIL IN FLAX-GROWING AREAS

If the soil is left in a rough, cloddy condition before the rains occur, absorption of the rainfall is greatly facilitated and soil wash is not so likely to occur.

However, certain small-seeded crops require a relatively fine seed bed in order to procure an even and satisfactory germination. Such a crop is flax. The well-prepared seed bed used for flax is particularly liable to sheet erosion, and the slender aerial growth and weak root system of the flax plants gives little protection to the soil for some time after the crop has appeared above ground.

Fortunately, from this point of view, flax is usually only grown for one year, at the most for two years running, in a rotation of five to seven years, in order to reduce the likelihood of the occurrence of flax wilt.

However, it is important that there shall not be an unrecorded debit for lost soil fertility and depreciated capital value of the land during the years in which flax is grown on the land. Nor is this the only aspect of the question. The land upon which flax is grown is not unlimited in extent, and if the Kenya flax industry is to become large and flourishing and high quality seed and fibre are to be produced, it is important that the fertility of all potential flax land shall be safeguarded.

For this crop, as for other annual crops in the European areas of Kenya Colony, broad-base terraces afford the most suitable and efficient means of erosion control.

All farmers who are contemplating the growing of flax during the 1940 season, when a considerable increase in the area under the crop is to be expected, should make arrangements to terrace this land beforehand, during the 1939-40 dry season. In this connexion, farmers are referred to the bulletin of the United States Department of Agriculture on Terracing for Soil and Water Conservation, and to the leaflet prepared by the Soil Conservation Service of Kenya Colony. Flax-growers are reminded that the Department of Agriculture is anxious to assist them in the solution of erosion control problems on their farms.

C. MAHER.

BANYANKOLE AGRICULTURE

By J. W. Purseglove, B.Sc., A.I.C.T.A., Agricultural Officer, Uganda Protectorate

The district of Ankole is situated in the south-west of the Western Province of Uganda and has a total area of 6,363 square miles. The equator passes through the north of the district. The average altitude is about 5,000 feet, ranging from 3,000 feet at Lakes George and Edward to 7,000 feet in Buhwezu. It is divided into ten *sazas* or counties, and the relations of its chiefs with the British Government were recognized by the Ankole Agreement of 1901.

Geology and Soils

Considerable attention has been given to the geology of Ankole on account of the occurrence of economic minerals—gold in the north and tin in the south, both of which are mined. Large areas are composed of ancient sedimentary rocks, the Karagwe-Ankolean system, in which claystones predominate. These often show intrusions of two closely related post-Karagwe-Ankolean granites. In north-eastern and central Ankole are fairly extensive areas of granites and associated rocks of unknown age. Below the Lake Edward escarpment the plains are composed of the Kaiso beds, an ancient fossiliferous accumulation of the Tertiary Period. Also in the north-west is an area with rocks of volcanic origin, mainly tuffs, and many small crater lakes.

Kaolinitic and sandy soils are derived from the granites. The Karagwe-Ankolean rocks are slow soil-producers in that they are relatively unsusceptible to chemical weathering. Consequently, in the drier areas their soils tend to be thin and are easily removed, but in the wetter areas they give rise to a deep red loam. A very fertile dark soil of good depth is derived from the volcanic rocks.

Climate

The rainfall of the district is on the whole inadequately known, but it ranges from about 30 inches per annum in the south-east to nearly 60 inches in the north-west. At Mbarara, the administrative headquarters, the average annual rainfall for the thirty years 1907-1936 is 35 inches. There are two wet seasons, namely September–December and February–April, the major dry spell occurring from May to August. The average monthly and annual rainfall at the various stations in the district is shown in the accompanying diagrams.

The average mean maximum and mean minimum temperatures at Mbarara are approximately 78° F. (25.5° C.) and 58° F. (14.5° C.) respectively.

Vegetation

The vegetation is varied, as would be expected from the wide differences in rainfall and altitude. The eastern areas are composed of tree savanna with undulating short-grass plains in which *Themeda triandra* is the dominant grass species. In the south-east, an area of drowned valley lakes, which has the low annual rainfall of not more than 30 inches, the country is somewhat arid with poor thorn scrub in which *Acacia* sp. predominate, *A. hebecladoides* and *A. stenocarpa* being the commonest. In these areas the Veterinary Department is carrying out a programme of bush clearance and fierce annual burning to eradicate tsetse-fly (*Glossina morsitans*). The tree savanna in the north-east and on the Lake Edward plains can be classified as good thorn scrub. Again *Acacia* sp. predominate, but *Albizzia* sp., *Erythrina abyssinica* and *Trichilea* sp. are subdominant. The Lake Edward

plains, with the exception of the fishing settlement at Katunguru, are a closed sleeping sickness area.

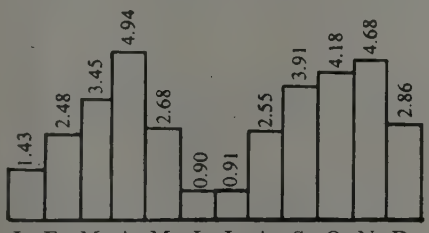
The south, south-east and much of the central area is composed of treeless savanna with grassy hills, and the soil is more fertile. Papyrus-choked streams are a characteristic feature of the landscape.

In the west, which receives the highest rainfall, the normal vegetative climax is high forest. This is often associated with grasslands which, at higher altitudes, show a more temperate type of vegetation with tree heathers, *Philippia benguelensis, Lobelia gibberoa* and *Protea madiensia.* This area, which is the most fertile, contains the only extensive forests in the district.

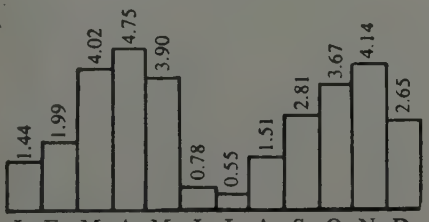
Elephant grass (*Pennisetum purpureum*) is nowhere indigenous in the district except possibly in Bunyaruguru.

ANKOLE RAINFALL

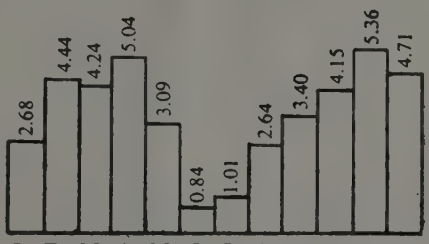
MONTHLY AVERAGES AT FIVE STATIONS



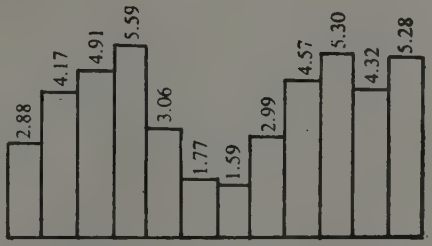
Mbarara Rainfall, 1907-36 (in inches).
Average for 30 years = 34.97 in.
Altitude 4,721 ft.



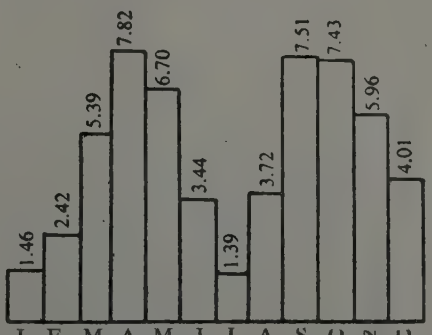
Mwirasandu Rainfall, 1930-35 (in inches).
Average for 6 years = 32.21 in.
Altitude 4,600 ft.



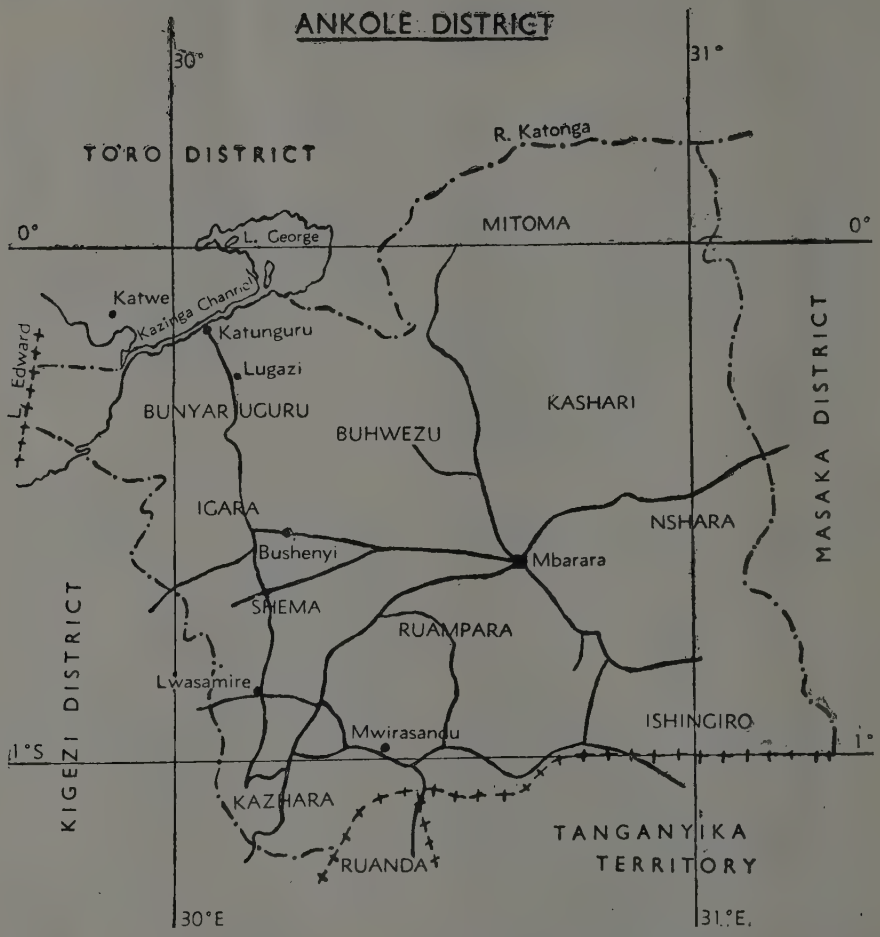
Lwasamaire Rainfall, 1929-37 (in inches).
Average for 9 years = 41.60 in.
Altitude 5,200 ft.



Bushenyi Rainfall, 1930-35 (in inches).
Average for 6 years = 46.43 in.
Altitude 5,360 ft.



Lugazi Rainfall, 1918-35 (in inches).
Average for 18 years = 57.25 in.
Altitude 4,000 ft.



Inhabitants

The indigenous inhabitants of the district are Bantu agriculturists, known to their neighbours as Bairu. In comparatively recent times, the Bahima, a race of cattle-owners of Hamitic descent, invaded and conquered the country, and Ankole is now regarded as the true home of the Bahima. In other districts, such as Toro and Bunyoro, which the Bahima also conquered, they tend to have intermixed with the local tribes, but in Ankole they have remained relatively pure. It is probable that the Bahima adopted the language of the conquered Bairu, and the two tribes are jointly known under the name Banyankole. The Bahima were the ruling class, the Bairu living in a state of serfdom to their Bahima overlords. Although no political distinction now exists, the king (or *Omugabe*, as he is called) and many of the leading chiefs are Bahima.

In the fertile saza of Bunyaruguru live the Bakunta, who are numerically few and who closely resemble the Bairu. They are of mixed origin, a group of Baganda having intermarried with the local tribe.

According to the 1931 census returns the total population of the district was 278,951, of whom 9 per cent were Bahima, and 80 per cent Bairu. The remaining 11 per cent belonged to other tribes, who came into Ankole from time to time and were mainly Baganda, Banyaruanda and Bakiga. The number of taxpayers in 1938 was nearly 60,000.

Bahima Cattle-husbandry

The Bahima are essentially a cattle people, and Lukyn Williams, Mackintosh and others have shown how their entire life and customs are centred around their cattle. Before the present administration all the cattle were individually owned by the Bahima, though the *Omugabe*, as head of the state, could claim all or any cattle in his country. Now the Bairu also are acquiring cattle, and at the end of 1937, out of a total cattle population of 218,019 head, only 60 per cent were owned by Bahima. The percentage owned by the Bairu is increasing yearly.

The majority of the Bahima live in north-eastern and southern Ankole, and they may be regarded as semi-nomadic in that they often move their stock to new areas in search of fresh pasturage and water and on account of disease; but water shortage is the dominant factor in this migration. In the areas where salt-licks are present the Bahima take their cattle to them once a month. In other areas salt is bought or carried from Katwe. The Bahima own very few sheep, goats or fowls, and these mainly for sacrificial purposes.

Their breed of cattle is known as the Ankole longhorn. The predominant colour is red of various shades, the hump is absent or rudimentary, and the excessively large horns are a characteristic feature of the breed. The average weight of a dressed longhorn carcass is 450 lb., and the milk, though small in quantity as compared with European standards, is particularly rich in fat. The Bahima have a fair knowledge of the principles of breeding, but they consider size of horn and colour more important than milk and beef production. Each member of the herd is given a name according to some physical character and will answer to that name.

The cattle are kraaled at night in a circular enclosure, usually made of acacia branches. The owner's house is built into the wall of the kraal, and is usually a temporary structure of sticks and grass. Only the young calves are put under cover at night, and these in the owner's house.

The Bahima diet consists of milk, occasionally supplemented with meat and blood from their cattle. They will eat the flesh of the buffalo and eland, but of no other animal. Blood is obtained by piercing the jugular vein, and may be drunk alone or with milk, or mixed with butter and salt and cooked. The Bahima believe that should milk come in contact with any vegetable food in the stomach their cattle will suffer in consequence. Thus, after eating such food a Muhima must not drink milk for twelve hours, unless he first takes a strong purgative. Consequently, as their diet consists almost exclusively of milk, the Bahima seldom eat vegetable food, and so do no cultivating. They do, however, drink native beer, which they buy from the Bairu. In Kazhara the Bahima of Mpororo cultivate finger millet (*Eleusine coracana*) and sorghum which they make into beer. Butter is made by the Bahima and may either be eaten or used as an unguent.

The cash income of the Bahima is derived from the sale of stock and stock

products. The average price for longhorn cattle at the Ankole cattle auctions during 1937 was Sh. 68/95 per head, but only the worst stock is sold, usually old or barren cows and scrub bulls. Most of the bull calves are killed and eaten shortly after birth, as there would be insufficient milk for household consumption if all the calves were reared. This results in an unusually large percentage of female stock in Bahima herds, and a paucity of young male stock for sale. In the 1937 cattle census 90 per cent of Bahima stock were females. There are no craftsmen amongst the Bahima, and milkpots, spears, charms and personal adornments are bought from the Bairu. Bahima who have lost their cattle will work as herdsmen until they can afford to buy more cattle.

Bairu Agriculture

As has already been stated, the Bairu, who are the cultivators of the district, are far more numerous than the Bahima. They are grain-eaters, by contrast with their neighbours on the east, the plantain-eating Baganda. They live a settled life and their cattle are kept near the houses, with the result that there is very little migration of Bairu-owned stock. The Mwiru lives on his smallholding, with his plantain garden which is primarily for beer production near to or surrounding his house, and his plots of annual crops nearby. His house is usually of the bee-hive type, made of poles and grass, but the more progressive and richer peasants are beginning to build mud-and-wattle houses. *Themeda triandra* and *Hyparrhenia* sp. are the grasses used for thatching.

The Bairu are most numerous in the wetter and more densely settled central and western counties, but even so there is still ample land for a large increase in population before it becomes over-populated. In the eastern area which, with the exception of Mitoma county in the north-east, is sparsely populated, shortage of domestic water and low rainfall are the factors which limit settlement.

Practically all Bairu possess sheep, goats and fowls, and the number of Bairu-owned cattle is rapidly increasing. Most Bairu men will eat the flesh of sheep and goats, but they may not eat pig, fish, fowls or eggs. The women are forbidden to eat mutton or goat. These food taboos do not apply to the Bakunta. Milk cannot yet be considered a normal part of Bairu diet. Unlike the Bahima, it is not general for the Bairu to kill the majority of the bull calves shortly after birth; the proportion of bulls is far higher than in Bahima herds. In the 1937 cattle census, out of 86,428 head of cattle owned by the Bairu, 23 per cent were males.

In *mutala* surveys[1] carried out in Ankole the average area under cultivation per family was found to be approximately three acres, of which two acres were under perennial crops—plantains, coffee and cassava, the plantains occupying by far the largest area. The remaining acre is put down to annual crops, mainly finger millet, sweet potatoes, beans and sorghum. The annual crops, and occasionally coffee, are often planted collectively, but not communally, the individually owned plots being grouped together on patches of good soil.

The bulk of the cultivating of food crops is done by the women, and the short-handled hoe, *enfuka,* is used throughout the district. An attempt was made in 1930 to introduce ploughing with Ankole longhorn cattle, but it was never

[1] See Ref. [7], and also this Journal, III, May, 1938, p. 450, and IV, Nov., 1938, p. 211, where the word *mutala* is defined.—*Ed.*

popular and this method of cultivation is no longer employed. *Omuhoro,* an implement shaped like a question-mark, is used in clearing bush, cutting wood, etc. It has two cutting surfaces, one on the inside of the curve and the other on the straight portion below, and is made by the local blacksmiths. They also make *oluhabyo,* a knife with a curved blade attached to a long handle; it is used for cutting down bunches of bananas and trimming the plantains.

No definite rotation is practised, but it is usual to plant sweet potatoes or finger millet on new land. In Kashari county it is customary to plant beans on new land and when they are flowering to broadcast finger millet on the same plot. Two to three crops of finger millet are usually taken off the same plot before planting it with sorghum, which is usually the last crop to be taken before allowing the plot to revert to bush. The land is allowed to rest for from three to eight years before being brought once again under cultivation; the length of the fallow period will depend on the density of the population, the quality of the land and the judgment of the individual.

Much of the cultivation is on the hillsides and the cultivators always work uphill, with the result that the whole of the soil is moved down the hill about a foot every time the plot is dug. After clearing the land, which is always done by the men, and a shallow preliminary cultivation, the land is allowed to rest for two to three weeks, after which a deep and thorough cultivation is made. The crops are then planted.

It is against traditional practice to use kraal manure, but during the past two years a few of the coffee and food plots have been manured. It is hoped that the custom will become general throughout the district.

Bairu Food Crops

Finger millet (*Eleusine coracana*), known locally as *obulo,* is the staple food crop of the Bairu, who recognize many varieties of the crop. The land is cleared in June and July, and is sterilized by burning grass or brushwood on the plot; the seed is sown with the autumn rains in the period from the end of August to the end of October. It is always broadcast. Occasionally, it is planted with the February rains. Weeding and thinning are done by hand, in October and November. After the formation of grain, children spend the day near the plot scaring birds, and scarecrows are often erected. Harvesting of the autumn-sown crop takes place in January. The heads are cut off with a small knife (*engyesho*), and the straw is left standing. The heads are then piled in heaps for up to a week, during which time heating takes place and ripening of the grain is completed. *Obulo* is always stored in the head, and is usually placed in basket-like circular granaries (*ebitara*) raised from the ground. There are many ceremonies connected with the sowing and harvesting of the crop.

When the grain is required for eating, small quantities are threshed by beating with sticks and winnowed by letting it fall from a height, the threshed grain being placed in trays for this operation. It is then hulled in a wooden mortar and after further winnowing is ground into flour between two stones. The flour is made into a stiff porridge which is usually eaten with beans or peas, wild spinach-like vegetables, and meat when obtainable. A thin gruel called *obushera* is sometimes made from *obulo* by mixing the flour with boiling water and then adding ground grain that has germinated. *Obulo* can be stored for six to seven years and still remain edible; famine reserves of this grain are maintained at all village headquarters.

Sweet potatoes (*ebitakuli*) are an important food crop in the district, and many varieties are to be found, which are differentiated by leaf morphology and the length of the growing period. They are usually planted at times when little work is required on the finger millet crop, e.g. in November, or in February and March when it has been harvested. They are planted on mounds, which are about four feet from crest to crest, four slips being planted on each mound. Sweet potatoes are never stored by the Bairu but are left in the ground until required. By planting varieties with varying growing periods they are available for a considerable time.

Beans (*ebihimba*) are one of the few legumes grown by the Bairu for food. *Phaseolus vulgaris* is the species grown, and the seeds are of many colours. They may be planted with either the spring or autumn rains, and are often grown in mixed cultivation with maize and sorghum, more occasionally with *obulo,* and often under young coffee. They are harvested in the pod, and after threshing are boiled, salt is added, and they are eaten with millet porridge as described above. Occasionally the immature pods are cooked and eaten, and in times of famine the leaves are eaten like spinach.

Peas (*obushaza*) are grown in small quantities in Western Ankole, and are usually planted towards the end of the spring rains.

Plantains (*orutokye*) are grown throughout the district; 80 to 90 per cent of the plantains in Ankole are of the varieties used for beer-making, and are grouped under the general name *entundu.* They may be distinguished from the eating varieties by the black pseudo-stem and the green midrib of the leaf.

Beer must be regarded as a very definite food of the Banyankole. Brewing permits are issued by the Native Government, and they constitute a source of considerable income. In beer-making the plantains are cut when fully grown and ripening is hastened by putting the bunches in pits lined with plantain leaves and covered over with leaves and soil. Artificial heat is often applied by leading a flue into the pit from a fire nearby. They are kept in the pit from four to five days, when they are taken out, skinned, and the juice extracted by treading with the feet, grass being mixed with the pulp to assist extraction. The juice is then placed into a large canoe-shaped vessel (*obwato*), which is hollowed from a tree trunk. Sorghum that has been roasted and ground is added to the juice in the *obwato* and the mixture is then covered down. Great heat is generated, and after twenty-four hours the beer is ready for consumption. Unfermented banana juice (*ensande*) to which sorghum is not added is also drunk.

In times of food shortage beer bananas are eaten, and they may be dried and stored as a reserve. The eating plantains, *enyamwonyo* and *enkonzha,* are increasing in popularity among the Banyankole. They are a fairly recent introduction into Ankole, and probably came from the neighbouring kingdom of Buganda. The plantain gardens usually show a high standard of cultivation, all surplus vegetable matter being put down as a mulch. The average acreage under plantains per householder is about 1.7 acres.

Sorghum (*omugusha*) is planted with the spring rains, and is harvested in July and August. Each householder plants a small plot of sorghum, which is used solely in the making of beer. Small patches of maize (*ebicholi*) are usually grown in the mixed cultivation with other crops. The custom of planting cassava (*ebiribwa*) as a famine reserve is increasing. Other food crops such as groundnuts

(*ebinyobwa*), onions (*obutunguru*), cowpeas (*enkore*), and *Voandzeia subterranea* (the Bambarra groundnut—*empande*) are grown locally in small amounts.

Cucurbitaceous and solanaceous vegetables are grown near the homesteads and wild vegetables for use as spinach are collected; of these, *Amaranthus* sp. (*enyabutongo*), *Gynandropsis pentaphylla* (*esoge*), and *Solanum nodiflorum* (*eshwiga*) are the principal species.

The Banyankole have a very extensive assortment of useful and medicinal plants, of which the writer is making a collection, in the local flora.

Economic Crops

Coffee is the most important economic crop in Ankole. In 1911 twenty selected natives were sent to Kampala for instruction in coffee-growing, and seed was distributed in 1912. In 1924 nurseries were established throughout the district. By 1929, 721 acres had been planted, and in that year the production was 20 tons of hulled coffee. By 1936 the production had risen to 218 tons, but there has been a slight reduction during the last two years.

The plots are usually small, about one-tenth of an acre in size. A native staff is employed by the Agricultural Department to visit coffee owners and give instruction in coffee management. Coffee seedlings are supplied from 25 nurseries maintained by the Department and the Native Administration.

Marketing is controlled by the Native Produce Marketing Ordinance. Eleven gazetted buying centres have been established throughout the district and licensed buyers purchase coffee at stores which they have erected at these centres.

In the past practically all the coffee was Arabica, but the variegated coffee-bug is a very serious pest in all *sazas* except Bunyaruguru, and does extensive damage. The species is *Antestia lineaticollis* Stal., but in the volcanic area of Bunyaruguru *A. faceta* Germ. is found. It is difficult to account for the difference in species in areas in such close proximity and connected by large forests, also for the rarity of the bug in Bunyaruguru and the negligible amount of damage it does. The high incidence of Antestia in the district, with the resultant loss of crop, has discouraged many of the growers. The *Nganda* variety of *Coffea robusta* is now being issued, as this variety is more resistant to Antestia attack. The peasants are being encouraged to plant the *Nganda* coffee under plantains.

Stephanoderes hampei is only a serious pest in the lower-lying *saza* of Bunyaruguru, and here the parasite *Prorops nasuta* has been liberated and recoveries have been made.

The cultivation of tobacco on a fairly large scale was started in 1936, when a crop of White Burley was grown in Bunyaruguru and Igara, and was air-cured. In the former *saza* the crop was successful and 39,140 lb. of cured leaf, with 62 per cent Grade I, was sold, representing an average yield of 400 lb. per acre.

In 1937-38 Blue Pryor and Western varieties were grown in the same *sazas*, the barns being modified for fire-curing. As in the previous season, the crop was planted in September, but very cold and wet weather at the time of topping and suckering facilitated the spread of a virulent and unusual form of mosaic disease, which caused severe spotting and scorching of the leaf. This form of mosaic has been recorded from Southern Rhodesia, where it was found to be associated with periods of slow growth in mosaic-infected plants, under weather conditions similar to those experienced in Ankole in October to December, 1937. The total production of Grade I and Grade II leaf from

350 acres was 60,000 lb. of cured tobacco. Individual plots gave a yield of 660 lb. per acre.

Tobacco has again been tried. 400 acres were planted in October, 1938, the cured leaf being due to be sold in April, 1939. The incidence of disease was considerably less than in the previous seasons, but severe hail damage has marred the crop.

The opening up of the land for tobacco, the building of barns and the curing of the crop is done communally, but the plots are owned individually. As most of the tobacco is grown on the hillsides, the weeds are placed across the slopes as an anti-erosion measure.

Although it has been proved that tobacco can be grown successfully in Ankole, the crop is still in the experimental stage, and further trials are necessary to ascertain the most suitable time for planting in order to avoid the virulent form of mosaic, and hail.

Apart from the above crop the peasants often cultivate small patches of native tobacco, which they make into flat plugs for their own use and for sale to the Bahima and to the labour at the mines.

The mines provide a convenient market for the sale of excess food crops, and the practice of planting beans, groundnuts, and finger millet for sale to the mines and the Indian dealers is rapidly increasing, and now constitutes one of the most important sources of income.

Cotton has often been tried, but the district generally is too high for cotton, and the crop is not successful under Ankole conditions. A little cotton, however, is produced on the Toro and Masaka borders, where the conditions are more favourable.

Land Tenure

The system of land tenure is simple and effective. There exists an absolute security of tenure to the peasant cultivator and his heirs so long as he keeps the land under cultivation. Allowance is made for normal expansion and rotation, and the peasant is protected from anyone encroaching on his fallow land; for having once cultivated it, he has permanent rights. He has also the right to object to anyone cultivating too close to his holding. Land which is definitely abandoned may be reallocated by the chiefs, and objections may be raised to this reallocation. All disputes are settled by arbitration by the chiefs of the area concerned.

With the exception of small areas given to important chiefs by the Ankole Agreement of 1901, all the land is Crown land. Peasants living on these private estates pay a small rent to the owners.

In regard to the grazing of cattle, the land is not overstocked, and there is an abundance of suitable grazing land. A cattle owner is usually free to move his stock as he likes, and establishes his right to certain grazing by making the drinking trough for his cattle in the area. Should his cattle trespass on cultivated land he has to pay compensation for the damage caused.

Changes since Administration

During the present century there has been a great change in the relationship between the Bahima and the Bairu. Before the present administration the Bairu were a subservient people, often living in close conjunction with the Bahima, and performing work for them which the cattle customs of the Bahima forbade them to do for themselves. The meaning of the word Bairu is "slaves," and it was probably a term of derision applied to them by the Bahima or a neighbouring tribe. They were not slaves, however, as they were free to move about the country and to leave one master and join another at will. In those days they owned scarcely

any cattle, and were entirely dependent upon the Bahima for any trade which they did. They sold beer and tobacco to the Bahima, and received payment in kind, usually sheep and goats, for any service rendered to their overlords. All the craftsmen and most of the witch doctors were Bairu.

Now the Bairu are almost completely independent of the Bahima, whereas the Bahima still require the milk-pots, churns, stools, spears, anklets, etc., which are made by the Bairu craftsmen, and beer and tobacco. The Bairu can now earn their taxes by the sale of economic crops, by working at the mines or on the cotton plots of the Baganda. This last practice, which involves leaving the district for considerable periods, is detrimental to the development of the district, but is decreasing. The rapid growth of the mining industry has created a demand for local labour, and affords a convenient market for foodstuffs and other native produce. The total wealth and income of the average Muhima is considerably greater than that of the average Mwiru, but it is entirely dependent on his cattle, whereas the Bairu have several available sources of income. At present the Bairu have little desire for money, merely requiring enough to pay their taxes and a few extra shillings for clothing, etc. Their wants are still few and simple. Once the Bairu develop a desire for money, however, their economic system will be reorientated and further changes will occur.

It has been shown that the Bairu are now acquiring cattle, and that the number of Bairu-owned cattle is rapidly increasing. Mackintosh has pointed out that the herding customs of the Bahima increase the incidence of disease. This factor, and dietary taboos which are responsible for the wasteful slaughter of bull calves, result in checking the increase in Bahima herds, whereas neither of these checks operates on Bairu herds. Unfortunately, there is a tendency for Bairu, as they acquire large numbers of cattle, to ape the Bahima, and to make the Bahima mode of living their ideal. By agricultural propaganda the Department hopes to avoid this and to build up a system of agriculture based on mixed farming.

There is little danger of overcrowding or overstocking for some very considerable time. Some of the tsetse areas have already been cleared of fly, and more land thus made available for stock. There is ample room for expansion, and if the Bairu can be persuaded by agricultural education to develop a system of mixed farming the future will see a great advance in their status. If the Bahima are to survive, they will have to follow the Bairu example and cease to be nomadic.

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GREEN MANURIAL AND CULTIVATION TRIALS
MADE AT MOROGORO, EASTERN PROVINCE, TANGANYIKA TERRITORY

By N. R. Fuggles-Couchman, B.Sc. (Lond.), Dip. Agric. (Cantab.), Agricultural Officer, Tanganyika Territory

All native crops in the Morogoro district, and in the Eastern Province generally, are grown on the flat. The only exception to this rule is the sweet potato crop, which is frequently planted on large raised beds. Deep cultivation is only given to the rice lands, and that is only to the depth of a hoe blade, some four inches. Maize, sorghum and cotton, and generally pulse crops, are all planted in land from which the grass cover has been hoed and the trash burnt on the ground if it is at all bulky. The only cultivation given to the land before planting is the stirring of the top one or two inches when hoeing out the grass cover, and the only manuring consists of the plant ash remaining on the fields after burning the grass and weeds. It is therefore not surprising that the average yields from native crops are low, except on particularly rich soils, and that late planted crops in droughty years are almost complete failures.

With a view to finding practical methods of increasing the yields of native-grown crops in an area where there are no cattle, cultivation trials with maize were laid down at the Morogoro Experimental Station in 1936. Investigations on the green-manuring of maize were also undertaken to obtain an idea of the value of digging under ridges the grass cover which was cut in clearing the fields, compared with the growing of sunn hemp and ridging it over. The experiments were laid down on a brownish-black, free working plains soil of moderate to poor fertility, which has been under cultivation for many years. The rainfall during the growing season is shown in the tables in which are set out the results of the experiments.

Cultivation Trials with Maize

These trials were laid out in six randomized blocks, each of three treatments, which consisted of—

(1) Native fashion; no deep cultivation, but grass left on plots as mulch.
(2) Weeds drawn into rows and ridged over.
(3) Weeds taken off plot and soil dug with hoe to a depth of four inches.

The results are set out in Table I.

TABLE I

Mean Yields Per Six 1/40th Acre Plots in Lb. of Grain

Year	Rainfall in growing period, in inches	Ridging	Deep cultivation	Native	Seasonal totals
1936 ..	33·7	155·1	179·8	114·9	449·8
1937 ..	28·1	325·4	231·4	184·8	741·6
1938 ..	24·3	293·9	247·7	155·8	697·4
3 years' treatment totals ..	—	774·4	658·9	455·5	—

Difference required for significance (P.=·05)
3 years' treatment totals .. .. 82·7
Seasonal treatment means .. .. 47·7

In each season the development of the maize planted in undug soil was visibly inferior to the other two treatments. It was slower in growth and yellower in colour, and in 1937 in was difficult to establish a good stand in the plots.

From the results of the three years' experiments, ridging has been shown to

give higher yields than deep cultivation, which in turn has given higher yields than the native method of planting in undug soil. In 1936 the experiment was planted on particularly poor soil. It was a year of heavy rainfall and there was no difference between the value of ridging and deep cultivation, but in the two following, drier years ridging has given superior yields to deep cultivation. The mean increase in yield in favour of ridging over flat undug soil is equivalent to 3¼ bags of grain per acre, or Sh. 26 at present prices.

The results of this experiment are of particular value in the Peasant Settlement Centre at Kingolwira. Eventually all the natives in that settlement will own oxen so that they will be able to ridge their land expeditiously. It will take a very considerable period to convince natives in the district, however, that the increased labour of ridging their maize lands by hand-hoe will give considerable increase in grain. But a practice that the Wasukuma of the Lake Province have been obliged to adopt in order to maintain production and minimize erosion is also within the powers of the natives of the Eastern Province. They can increase their food production from the area of land now under the hoe by the judicious use of ridging. This would entail planting the maize and sorghum crops separately, each crop more closely planted in its own field, and the maize on ridges.

Green-manuring Maize with Sunn Hemp

The lay-out of these trials was similar to that for the cultivation trials, eight randomized blocks of three treatments being used. The treatments were:—

(1) Sunn hemp sown broadcast in the early rains and ridged over about 45 days later.
(2) Weeds ridged over.
(3) Weeds carried off the land, which was then ridged.

It was the original intention that three weeks should elapse between the ridging over of the green material and the planting of the grain, but climatic conditions in 1937 and 1938 did not allow of this. However, the maize showed no signs of being adversely affected in its growth by being sown within two days of burying the green material.

The results are set out in Table II.

TABLE II

Mean Yields of Eight 1/40th Acre Plots in Lb. of Grain

Year	Rainfall in growing period, in inches	Sunn hemp	Weeds	No green material	Seasonal totals
1936 ..	33·7	145·0	102·5	83·2	330·7
1937 ..	28·1	143·9	103·8	103·0	350·7
1938 ..	24·3	490·6	347·4	312·8	1,150·8
3 years' treatment totals ..	—	779·5	553·7	499·0	—

Difference required for significance (P.=·05)
3 years' treatment totals .. .. 104·3 lb.
Differences between seasonal treatment means cannot be compared in this table owing to the large increase in crops in 1938.

Each year the plots in which sunn hemp had been turned under could be picked out by eye. The plants were strong, deep green in colour, and had altogether a healthier appearance. Each season green manuring gave a very significant increase in yield over the unmanured plots. In 1936 and 1937 the sunn hemp plots also gave a significantly greater yield than those plots in which weeds only had been used. The serial results for the three years show that green-manuring with sunn hemp will give a considerable increase in crop, but that weeds alone do not increase the fertility

of the soil, the difference in yield between that treatment and the unmanured plots not being significant. The success of this form of manuring is dependent upon adequate rains in December. At the end of 1938 it was impossible to sow a green-manure crop because of the failure of the short rains. It has been shown further that the effect of green-manuring with sunn hemp in Morogoro only lasts one year. In the second year no differences have been obtained from the same plots replanted with maize.

For the native without oxen and using hand implements, the idea of green manuring would have to follow on establishing the value of ridging for his maize crop. Once having established that practice the only additional work is the sowing of the sunn hemp seed and perhaps one weeding, although that was not found necessary on the station. Green manuring on a field scale was costed out on the Experimental Station in the 1937-38 season. The total cost of broadcasting the seed, harrowing it under, and cutting the standing crop, and ridging it over with a maize ridger and oxen was only Sh. 2/07 per acre. For this small outlay an increase of some four bags per acre can be obtained.

RAMIE IN CALIFORNIA*

Ramie (Boehmeria nivea *Gandich.*) *has from time to time been considered as a possible crop for East Africa, and experiences with it, and some divergences of view, have been the subject of contributions to this Journal* (*Nov.*, 1937, *March and July*, 1938). *The following account of another country's adventures with the crop will be of interest.*

In 1870 John S. Finch exhibited ramie stalks and fibre at the State Fair. The plant had been introduced and grown by him at Haywards, Alameda County. A special gold medal was recommended for his display. About that time a great prize was offered by the Government of India for a machine that would successfully displace hand labour in extraction and processing of ramie fibre for manufacturing. In 1874 Finch and others associated with him constructed an elaborate combination of rollers and dipping tanks through which the ramie stalks were passed in series by a succession of belts and carriers. This machine was started for India to be entered in the competition and to give an exhibition in the Hawaiian Islands *en route*. It arrived in the Islands in due course, but was never carried nearer to the competition nor the prize, and the idea of growing ramie in California was for the time abandoned. In 1880 other inventors of ramie machines and processes appeared, and in 1890 still others. The latter group gathered influence enough to secure the passage of a State law in 1891 creating a "department of ramie culture," which undertook official promotion of a machine for fibre extraction and of ramie culture to provide the raw material. The result was a boom for vendors of ramie plants and the filling of much ground here and there with roots from which the growth was worthless because no device nor process came through profitably. In later years other promoters have operated with other machines and ramie plantations, but no industry has been established nor notable product marketed to this day. The growth of the ramie plant in California is excellent, and immense areas are suited to it, but sound inducements towards its production have not yet appeared.

* Extract from *Rural California*, by E. J. Wickson (MacMillan & Co., New York, 1923); p. 204.

INGEREZA NG'WANA SWEYA: HIS OWN STORY AND HIS AGRICULTURAL PRACTICES

By N. V. Rounce, C.D.A., A.I.C.T.A., Tanganyika Territory

I—His Own Story

"I was born in the village of Jana in Kahama District.[1] At the age of two I was captured by an Mnyamwezi as a slave, and I was sold to a person in Mbogwe Chiefdom. In this chiefdom there were men whose wives had been captured by Mtemi Milambo and they wished to take slaves to him in order to reclaim their wives, so I was taken to Mirambo and remained there for two years. But this Chief had a sister who had married but had run away from her husband, consequently Mirambo had to return the dowry. So he sold me to Ng'wana Masuli of Ilalanguru in order to obtain money, and I went to live with him in Unyanyembe. It was a cleared area when I went there and I cannot say how long ago it had been cleared, but I was fifteen years old when the Germans first reached Ng'habola, so you can judge approximately how long ago it was.[2] There I lived and when Ng'wana Masuli died I stayed there with my mother.[3]

"Before I became a man I made two trips to the coast, and when the Germans were in the country I made another three journeys to Bagamoyo carrying elephant tusks for the Arabs. I went of my own free will in order to buy clothes. I was about seventeen years old when the Germans first arrived in Tabora.[4] I then cultivated with my mother in the fields by the roadside near to Ilalanguru village; this was at the time when Ng'wana Kiungi was Chief of Unyanyembe. Then when Kiungi was killed by the Germans owing to the battle that took place after an argument over some maize cobs, I moved to the site which is now cultivated by my wife and which has many mango trees in it. Then I made another journey with the elephant tusks of Bwana Sefu[5] to Dar es Salaam, and there I joined the *safari* of Bwana Sakalani which was ready to go to Uhehe to fight against Mkwaba.[6] I carried a load to Uhehe because I wanted money. There I helped to build the *boma* at Iringa, and when I had reached the coast to draw my money and buy clothes I returned to Ngh'abola. Again I went to the coast with tusks, and worked on a coffee estate near Muheza felling the forest, where I remained two years. This was my last visit to the coast.

"My house was amongst those mango trees there, but then I still cultivated and manured the field I spoke of before on the roadside. I did not stop cultivating that till two years after Mtemi Kalunde came to the throne.[7] My bwana and my mother were now dead, and I married and continued to cultivate my owner's fields. At first, I knew nothing of spreading manure, but soon I saw an Mdushi doing it and I followed suit. At this time my first wife was still alive. I had no children by her. When she died I moved my house to its present site; that is the

1 In the northern part of the Central Plateau, to the south of Lake Victoria, Tanganyika Territory.

2 Masuli felled the land probably six to ten years before Ng'wana Sweya was born, so that the land has been under cultivation for at least 70 years.—N.V.R.

3 Actually the slave-owner's wife, the only person he ever recognized as a mother.—N.V.R.

4 1890.

5 A well-known Liwali of Tabora.

6 About 1905.—N.V.R. (Bwana Sakalani was possibly Hauptmann von Prince, who built the great house at Sakarani in Usambara; he fell in the battle of Tanga in 1914.—*Ed.*)

7 1901.

"I was born in the village of Jana."

very same house you are sitting under now. I have never thatched it since that time, except last year I added a little grass at the top. It is thatched *namna ya magele,* and it lasts a long time.[1] As there was no *itongo*[2] here I spread some manure close by here to make an *ifula lya mpindo,* that is a garden of healthy crops near my house. No other parts of this holding have had cattle manure. I do not know why I stopped using manure, though I know that later on in Mtemi Sayidi's time we had no opportunity to do any other work after harvest as we were called up to do communal work for him. Anyhow, I found that my groundnuts were producing a lot of *makebede* (empty shells), and so on the northern fields I began to spread ant-heap soil, because I saw that groundnut plants growing on ant-heaps did not have empty shells. I then began to mix leaves, especially mango leaves, with ant-heap soil in order to make compost, and soon saw that applying this improved my crops. Of the four methods I follow of maintaining fertility, namely cattle manure, ant-heap, ashes, and leaves and straw, by far the best is the first, but it was so far away I could not undertake it, and I had no money to pay others to help me. But this year I am going to use it again, and I may desist from applying ant-heap for a year or two. On cassava plots I put dried mango leaves under the ridges when the boughs are cut down and have been used for firewood, and the leaves remain. A fallow of two years will not produce as good a crop as an application of manure, and I do not fallow on purpose, only because there is not always enough rain. That female date palm was planted when I paid my first tax to the English,[3] and last year was the first year I have fallowed a plot since that time. For seventeen years I have spread ant-heap on the northern plots but the last three years I have attended to the southern ones, where previously I had merely spread all house rubbish and straw. Now I have reversed the process, and the northern fields get the rubbish. You ask me why I make my ridges straight. I saw straight lines at Muheza and brought them to my home

1 House built in 1919.—N.V.R.

2 A disused cattle kraal or house site which when cultivated becomes an *itongo,* and is of course very fertile.

3 1919.

"A fallow of two years will not produce as good a crop as an application of manure."

"His great desire seems to be good groundnuts."

"He insists on the importance of preparing his land."

because they pleased me. In 1929 I married my second wife. Yes, I had lived a long time a widower. We received Sh. 200 in dowry for my second wife's daughter, but she preferred to spend it to buying cattle, which always get stolen by the Badushi. I have some of my own at Samuye (in Shinyanga), but I am not such a fool as to bring them down here. That is my wife's *kilaba*[1] which she cultivates by herself; the ridges are a bit crooked and she doesn't follow my practices. We both work on all the other fields, but we each have our own operations to do."[2]

II—A Summary and Discussion of His Agricultural Practices

Ng'wana Sweya was born about 1873, and had a very varied career until 1908, when he settled down on the lands which his master had cultivated before his death. From this date he cultivated two acres of his present holding together with an old house site near to Ilalanguru village on the Kigoma–Tabora road. Ten years later he gave up the latter and took up another four and a half acres, to make up his present holding of 6.7 acres, of which he and his wife have planted six acres this year. He originally started manuring around the old house site, and discontinued the use of cattle dung soon after occupying the present unit holding. He has given various reasons for this, but is uncertain which was the deciding factor—

(1) An argument with the owner of the cattle, from whom he used to beg the dung.

(2) The distance of the cattle from his farm.

(3) The onerous work given to him by the chiefs in those days.

In any case he found that the fertility of his holding was fast decreasing, and as his great desire seems to be "good groundnuts" he began to break up ant-heaps,[3] on which he noticed groundnuts did not produce empty shells, and spread the soil on the adjacent land. Then, I think, the nearness of ant-heaps to his mango trees induced him to heap the mango leaves and cover them with ant-heap earth rather than with ordinary soil, in order to make them rot. What quantity of this he actually spreads on his land is difficult to estimate, and I think that probably one-third of the three-quarter-acre plot he treated this year was dressed with pure ant-heap owing to the exhaustion of his supply of crude compost, which he prepares under all the surrounding trees. He has chosen, for lack of anything better close at hand, an organic material which is very slow in decomposing, but he says that the mango leaves are rotted away in the course of a year. No farm wastes are overlooked and everything except groundnut shells is either decomposed beforehand or thrown into the furrows to rot under the ridge. The groundnut husks are thrown on to hig heaps of mango stems and, when they have been burnt in one of the fields, the ashes are spread.

He insists on the importance of preparing his land as much as he can before the rain falls, and as his compost, termite mound, straw, mango leaves and rubbish of every kind are laid in the furrows and covered with soil to promote decomposition, this completes the first customary operation of ridging *during the dry*

[1] Essentially the small plot which is given to young children to cultivate and on which they learn the methods of cultivation. The meaning is extended in this case to describe a field which is cultivated by the wife alone, the produce of which is her own property.

[2] This is customary; the man does the initial operation of pulling up one side of the ridge and the woman follows, sowing and completing the work.—N.V.R.

[3] The large ant-heaps (termitaria) in Unyanyembe are often richly calcareous, whereas the soil of the fields is acidic, poor in lime and other plant nutrients.—*Ed.*

season. This operation is normally completed in the rains. To get it done earlier is a practice which many agricultural officers attempt to popularize without success, as early planting is of such importance in areas of low rainfall.

Part of the $6\frac{3}{4}$ acre holding has been cultivated by Ng'wana Sweya for thirty years and the rest for twenty years, and certainly the surrounding fields bear no comparison to it in the crops they produce. It is a tribute to his agricultural practices that only in the last few bad seasons has he adopted the cultivation of cassava to supplement his grain crops. The quality of his groundnuts is excellent, and an experiment conducted at the local Agricultural Development Centre fully substantiates his claim to the benefits accruing from the application of ant-heap soil to groundnuts. In this experiment a 96 per cent increase in yield was recorded by the use of 32 tons of ant-heap soil per acre, whilst there was a corresponding increase of 13 per cent in shelling percentage. As regards quality, the kernels from the control plots were withered, light and many were black and mouldy, while those from the treatment plots were a bold and well-filled sample. It is significant that during the last two years, when failures of the groundnut crop have been experienced, he has reaped almost as good a yield and sample as in other years. He is an independent old man and will beg off nobody but the Government. As is not uncommon with those who have for long followed a practice for which they have been praised he is loath to modify it, or adopt any others, and in spite of his success not a single individual has followed his royal road to soil rehabilitation.

MESQUITE

According to the *News Bulletin of the Empire Forest Departments* for the first half of 1939, very remarkable results are attending the use of mesquite (*Prosopis juliflora* DC.) in areas of extremely low rainfall in the sudan. Pot-raised plants survive in four inches of annual rainfall and make a good firewood growth. This species is defeating the goat, which will not eat its foliage, yet eats its pods and passes its seeds in a condition highly suitable for germination. Mesquite is escaping from the centres where it was originally introduced about twenty years ago. Mesquite seedlings raised in tin pots (costing Sh. 50 a thousand) are being planted out to the extent of over 200,000 in semi-desert sites. The fodder value of the pod of the species in its areas of origin (as to which see Mr. C. Maher's mention of it in the *East African Agricultural Journal* of July last, p. 38) has been confirmed in the Sudan. It appears to fruit best in rainfalls of less than eight inches and provides a much denser ground shade than any Acacia of those latitudes.

Low rainfalls of this order are, fortunately, in East Africa found only in Turkana and the Northern Frontier Province in Kenya and in the Pare-Usambara gap in Tanganyika. These Sudan results are nevertheless worth noting, as suggesting a means of providing a useful cover on bare over-grazed lands whose effective climate is that of a near-desert, even if the total rainfall they receive, and largely shed, is twenty inches or more. Dr. H. L. Shantz in the *Atlas of American Agriculture,* Pt. I, section E, Natural Vegetation, describes this mesquite species as often constituting the principal type in the sub-irrigated valleys of southern New Mexico and Arizona, a habitat which suggests that it might thrive on the broad expanses of some of our "sand-rivers," so both providing forage and assisting in flood-control at the same time.

RICE-GROWING IN CENTRAL KAVIRONDO

By G. Gamble, Assistant Agricultural Officer, Department of Agriculture, Kenya Colony

Rice was first introduced into Central Kavirondo by an officer of the Administration in the early days of the Colony and before the Department of Agriculture existed as it does to-day. Small areas along the Lake shore (Kavirondo Gulf, Lake Victoria) in the Nyakatch location were planted and fairly good results obtained, but unfortunately the growing of this crop was discontinued before any real progress had been made. The original seed was lost and the lake-shore areas were allowed to revert to papyrus. In the year 1934 rice was again tried in Nyakatch. On this occasion the Sena variety was planted, and the excellent results obtained justified opening up the area for rice-growing.

In 1935 it was decided that rice work in this area should be started on a large scale. There were two good reasons for coming to this decision. In the first place, Nyakatch is an area where a famine may be expected every few years and the introduction of rice, which does not rely upon rainfall but is irrigated by the waters of the lake, eliminates the danger of a serious food shortage. In the second place, there has always been a shortage of money in the Nyakatch location. Rice is a good paying proposition and ensures people having sufficient money for their needs.

The people were induced to plant up about one hundred acres of rice in 1935. The crop did very well indeed, and about fourteen hundred bags were sold. It was in the following year that rice really became recognized as one of the most important crops of Nyakatch, and that year may be taken as the start of the rice industry on the Kano and Nyakatch.

In the year 1936 large-scale rice trials were carried out on the Kano. The crop was planted under three different conditions:—

(1) Rice was planted in the nursery and then transplanted into prepared paddies in the swamps along the lake shore and other natural swamps.

(2) Paddies were prepared in dryish areas that could be easily irrigated. Rice was transplanted into these paddies and water was allowed to stand two to three inches deep. The advantage of this method is that the water can be controlled, and that the paddies can be dried out before weeding.

(3) Seed was broadcast direct into the paddies.

The two former methods proved by far the best, and the average yield obtained by natives was something over 30 bags to the acre.[1] The third method only yielded from ten to twelve bags to the acre, and consequently was not continued with.

During the following year this work was extended and some 550 acres were planted. Excellent yields were obtained, but owing to lack of food on the Kano the greater part of the crop was used for that purpose. The area was increased during 1938, but the people were loath to sell as they had acquired a taste for rice during the previous year and were storing it for food.

In the year 1936 rice cultivation started on a large scale in the swamps along the lake shore, and about four hundred acres was planted in a narrow strip some eight miles in length. Excellent yields were harvested, as may be seen in a later paragraph. The highest yield obtained in this

[1] The bag of 200 lb. 30 bags = 6,000 lb. rice (unhulled) per acre.—*Ed.*

area was about 42 bags to the acre, and the average yield about 31 bags.

During the following year the lake level was abnormally high, and this resulted in a decrease in acreage. The natives could not be induced to plant the crop farther away from the lake. This bad rice year, coinciding with a bad millet year, has done a great deal for the rice industry. The natives were forced to realize the value of rice, not only as a food crop, but as a cash crop. During the previous year the people had ample means, but in this year they were finding it difficult to pay their taxes. As a result the area under rice in 1938 increased tremendously. It was in January of this year that a furrow a little under eighteen miles in length was constructed from the Nguo River to Kusa (*see* map). This opened up a large new rice area. Work started in July, 1938, on opening up paddies on the lower side of the furrow. This was carried out on a different system from the other rice work. All paddies were marked out by staff of the Agricultural Department; each paddy was made approximately a quarter of an acre in size. People from all parts of Nyakatch came down to the furrow and were allotted as many paddies as they could work. Some families only took one, whilst other took as many as four. It was estimated at the end of the season that approximately 700 acres of rice was planted in Nyakatch—500 on the furrow and 300 on the lake shore. Yields were good, and the rice crop on this occasion may be taken as having prevented a serious food shortage; only a very small proportion of the crop was sold.

The natives, having learned the value of rice, have started work on the 1939 crop, and there is every likelihood of another large increase in the area under this crop.

The Rice Mill.—The help given to the Agricultural Department by Messrs. Rahim Jivraj & Co. with regard to rice-growing has been invaluable. This firm allowed their cotton instructors to carry out rice work in 1936, and offered to increase the number in 1937. This offer was gladly accepted. In October, 1937, Messrs. Rahim Jivraj & Co. opened a very fine up-to-date rice mill at Kibos. This was followed early in 1939 by Messrs. Nyanza Oil Mills, who opened a rice mill in their premises in Kisumu.

Rice Sales.—The following are the quantities of rice purchased since the 1934-35 season and the cash value:—

Year	Kano	Nyakatch	Total	Value
	Tons	*Tons*	*Tons*	£
1934–5 ..	—	41	41	157
1935–6 ..	—	166	166	639
1936–7 ..	98	311	409	2,861
1937–8 ..	55	5	60	559
1938–9 ..	132	115	247	1,478

NOTE.—All rice purchased before 1937 was transported to Mwanza and consequently was bought at a lower rate.

Conclusion.—One of the chief advantages of rice-growing is that the cultivation of rice does not clash with that of other native food crops. It is planted after the native millet crops have been harvested, and harvested in the dry months of January and February.

Another advantage is that yields are heavy. A native owning one acre of paddy can sell half to realize Sh. 125, and save the other half for food purposes. If he were to grow any other grain crop, he would have to grow five acres to get the equivalent amount of cash and at the same time sufficient food for his needs. Incidentally, the owner of a rice paddy has the advantage of not having to rely upon rainfall, and if he wishes, although it is not encouraged, he can plant two crops a year.

The following table gives some idea of the value of one acre of rice as compared with a like area of other crops:—

Crop	Yield (Bags of 200 lb.)	Price per Bag	Value
	Bags	*Sh. cts.*	*Sh.*
Rice (Paddy) ..	25	10 00	250
Maize	10	7 00	77
Mtama (Sorghum)	10	5 00	50
Wimbi (Finger millet) ..	6	8 50	51
Groundnuts ..	8	11 00	88

It is very rarely that 10 bags of maize or mtama are ever harvested from an acre of land on the Kano and Nyakatch, but 25 bags to the acre of rice is well below the average yields of Sena rice, the variety planted in these areas.

The cultivation of this crop has done a great deal during the last two years in preventing food shortage, and for this reason alone should receive all possible encouragement for an increase in acreage. There are large potential areas in the Kano and Nyakatch that are at present lying idle under papyrus and other water grasses but which could easily be turned into very profitable rice paddies.

The people of the Kano and Nyakatch are now beginning to realize this, which means that the future of the rice industry in this area is ensured, and that in the not too distant future the Kano and Nyakatch locations of Central Kavirondo should be one of the chief rice-producing areas of Kenya.

MAP OF KANO AND NYAKATCH (Rice areas stippled)

INVESTIGATIONS ON RICE

The following abstract of a bulletin reporting progress on a scheme of research on quality in rice, by Dr. A. Sreenivasan of the Indian Institute of Science, Bangalore, is reprinted from the Malayan Agricultural Journal *of July,* 1939.

This progress report of 22 pages deals with quality in milled rice and the effect thereon of polishing, parboiling, storage and manuring, and contains a miscellany of interesting observations.

Dr. Sreenivasan points out that comparison of specimens of raw and parboiled rices milled to different degrees shows that, with a limited amount of milling, parboiled rice does not lose as much nitrogen or phosphorus as raw rice. With increased milling, however, the difference tends steadily to diminish, until beyond the half-milled condition more nitrogen and phosphorus are removed with the polishings of parboiled than of raw rice, so that in a fully polished condition there is little difference in composition between the two types.

The reason for this difference in the rate of removal of nitrogen and phosphorus is, apparently, that the process of parboiling causes an inward diffusion of these constituents so that the higher concentrations which occur in the outer layers of the bran of raw rice are found further inwards in the bran layers parboiling. There is also diffusion of nitrogen and phosphorus from the bran layers into the starchy endosperm.

The results of analyses of commercial samples of rice show, however, that parboiled rice is somewhat richer in proteins and minerals than ordinary white rice. The reasons given for this are that since parboiling produces a coloured product even after polishing, and as the parboiled grain begins to break up if polishing is extended beyond a certain stage, it is not generally polished to the same extent as raw rice.

In addition to the above reasons, there is the fact that usually the coarser and coloured varieties of rice are used for parboiling. These have thick bran layers and contain more nitrogen and phosphorus than the so-called "superior" varieties.

It is concluded, therefore, that the generally higher nutritive value of parboiled rice is due to its being usually consumed in an undermilled state, and to the fact that less of the nutritive constituents are lost by the ordinary process of washing and cooking.

The fat and proteins of rice bran have a definite, though small, inhibiting action on the activity of digestive ferments.

It is stated that whole grains of cooked parboiled rice digest more slowly than those of cooked raw rice and require better mastication; but parboiling results in partial dextrinization of the rice starch so that under ordinary conditions, where proper penetration of the enzymes is ensured, such rice is more easily digested than raw rice.

Unpolished rice is slow to cook, but this and its digestibility and food value vary with the variety. Polished rice is more easily digested than unpolished rice, but the digestibility of half-polished rice may be better than that of highly polished rice. Much work, however, is still necessary to obtain a correct indication of the digestibility of unmilled or undermilled rice.

Samples of three different varieties of rice were stored as padi, and results showed that the cooking quality of the rice improved under good conditions of storage. Well-stored rice grains swell on cooking to about four times the original volume, and the cooked grains remain detached from one another; while rice from freshly harvested padi scarcely swells to twice its original volume and cooks to a pasty condition which prevents digestive ferments from coming into further contact with the mass. Trials have shown that well-swollen and detached grains are easily penetrated by the digestive enzymes.

Hulled, unpolished rice cannot be kept for more than a month, and deteriorates rapidly during storage, owing to the decomposition of the oil or fat in the pericarp or bran layers in contact with the moist atmosphere. The factors contributing to improved keeping quality in unpolished rice are being studied. Desiccation with airtight storage has been successful.

The chemical composition of rice is greatly influenced by several factors, such as type of soil, climatic conditions, seasonal variation and by manurial treatments. There is considerable variation in composition of different varieties.

The colour of parboiled rice may be improved considerably by reducing the time of steeping and parboiling. The use of certain

chemicals in the steep water also lightens the colour of the grain. Recently, a process has been patented by which a light-coloured product can be obtained by heating the steeped grain for very short periods at over 400° C.

Readers who are interested in the rice crop and its handling in aspects such as the above should know that an authoritative article on "Rice and its Importance in Human Nutrition" was included as Appendix 6 in the recently issued *First Report of the Committee on Nutrition in the Colonial Empire,* Part I (*see* the review by Dr. D. B. Wilson in the editorial columns of our last issue). The author of this article is Dr. B. S. Platt, who organized the "nutrition unit" that began work in Nyasaland at the end of last year; he has had long experience of dietetic problems in relation to peasant-grown food crops in China, and as both chemist and medical man is exceptionally well qualified to handle such a subject. He discusses the extent and importance of rice cultivation throughout the world, the variation in yields, the calorific value produced per acre, the composition of rice especially with regard to the "protective principles" it contains, the effects of conditions of ripening and harvesting, methods of storage and their relation to food values, the "parboiling" of rice, the effects of various degrees of milling especially as affecting digestibility and loss of vitamin B1, losses due to too-fastidious washing before cooking, and finally the cooking process itself. The article is somewhat too long and too technical to reproduce in entirety, but the last three paragraphs of his summary of main conclusions are worth quoting:—

The yield of rice attained in Far Eastern countries contrasts markedly with that in many colonial territories. This is a matter for agricultural departments to take up; it involves mainly the provision of irrigation works, the control of seed selection, weeds, and harvesting and the maintenance of soil fertility.

Large tracts of undeveloped land are to be seen in some colonial territories which, under proper irrigation, should provide suitable ground for rice cultivation.

Whilst there are differences in variety and cultural conditions which, to some extent, modify the nutritional value of rice, increased yield per unit area should be the first consideration. When conditions permit of optimal production, there is no food crop of comparable nutritional value which can approach rice in the amount of food produced on a given area. Moreover, it has a valuable sociological feature —it anchors a community to the place in which it has expended capital in the form of irrigation works, including terraces, conduits, bunds, pumping and other devices for water conservation and control.

"The mild Hindu adores his rice;
He always sends his plate up twice.
So when you next the pudding view,
Suppress the customary 'Pooh!'
And imitate the mild Hindu."

—E. V. Lucas.

A NEW OUTLOOK

"Financial institutions and farmers alike are beginning to change their outlook towards the land. Immediate returns are, of course, important—but the soil and its fertility must be preserved as heritages for posterity; there is everything to commend the old Chinese attitude towards "the good earth." In any case, it is obviously bad business to maintain annual returns at the expense of capital; and that is exactly what is done when crop production is maintained at the expense of the soil. Although this is still a very young country, a state of diminished fertility has already been reached in many instances, and the problem has become largely one of actually building up rather than merely maintaining fertility."

—This was written of New South Wales (*Agricultural Gazette,* August, 1939), but is it not equally true of East Africa?

SOUTH AFRICAN GRASSLAND INVESTIGATIONS—II

By R. S. Ball, M.A., Dip. Agric. (Cantab.), A.I.C.T.A., Agricultural Officer, Kenya Colony

The first part of this article appeared in the September number of this Journal, p. 146. It described pasture improvement and veldt management studies that are in progress at Potchefstroom, Cedara, and the several Research Stations of the Union Department of Agriculture.

At the University Farm, Pretoria, experiments have been carried out on the management of fertilized veldt pasture, and results of considerable interest have been obtained. The only drawback is that the whole experimental area was fertilized with mineral fertilizers, so that the effects on the veldt in the absence of fertilizer are not to be seen. It has been shown that uncontrolled grazing allows the earlier and finer grasses to be excessively defoliated and the coarse species such as *Cymbopogon* to run to seed. Thus it is difficult to control the composition of the herbage by grazing alone, since the coarser and more unpalatable species will tend to increase at the expense of the finer grasses. For these reasons, fire and the use of the mower are resorted to for the destruction of this unpalatable herbage, whose seeding is in this manner arrested.

As regards burning, it has been found necessary to burn only during the dormant season of the grasses when all food material has been transferred to the roots, but complete control can also be exercised by the use of the mower.

The heat of a fire kills very few grass seeds, and the rise in soil temperature during a fire is very small. Although experiments will show the optimum times for grazing and resting of veldt, yet the farmer is always faced with the difficulty of having a certain number of animals to consume an amount of grass which may vary several hundred per cent from year to year or season to season. For this reason the following experiment has been designed: Four bullocks are kept on an area of approximately 25 acres of veldt and are enclosed by a portable electric fence, the size of the enclosure being adjusted according to the amount of grazing available. The remainder of the area is unenclosed, but when the growth of grass is heavy it is conserved either as hay or silage as a reserve for the winter. The animals are fed entirely on this hay during the winter, and thus the area of 25 acres maintains them all the year round. During drought periods, the whole area may be required by the grazing animals, whereas at the time the station was visited during a period of heavy rainfall they were grazing over an area of only about four acres, the remainder of the area having been cut for hay. The amount of fodder conserved this year is adequate to keep the animals for two seasons, so that if there were a severe drought next year, and little or no hay could be made, a sufficient reserve would be available. By adjusting the size of the grazing area to the amount of grazing available at any time, deterioration of the herbage can be arrested, owing to the prevention of seeding of undesirable strains, and the prevention of overgrazing and treading out.

On the Pretoria Farm it has been found that the stock-carrying capacity (expressed as the ability of bullocks to increase in weight) of the veldt has been doubled by the adoption of this system, and the cattle do not lose weight in the winter when fed on the hay made over the area.

The results of the veldt management experiments, which include trials of grazing intensities over small areas, the effects

of burning, time of grazing, etc., show that overgrazing causes a marked decrease in the growth-rate of the shallow-rooted grass species, and that in the veldt produced as a result of overgrazing (*Cynodon* and *Digitaria* sp.) the productivity is extremely low. It has also been shown that the effect of fire is much greater on these shallow-rooted species, if they are burnt at any other than a dormant season. The type of veldt on the farm is sour high veldt, and is naturally of low stock-carrying capacity. The percentage of *Themeda triandra* in the herbage has been found to increase as a result of burning.

At the Frankenwald Research Station of the University of Johannesburg the chief aim is the study of plant succession and the relation of different species to their habitat. The bulk of the farm consists of land once devoted to arable cultivation which has been allowed to revert to grass, and the various stages of the succession are being studied. In addition, fertilizer and other trials are being carried out, but as before it has been found that applications of fertilizers rarely yield an economic return when applied to veldt, and should in preference be applied to artificially established pastures from which a greater bulk of herbage can be secured. Heavy stock concentration on reverted arable land encourages *Cynodon* and *Digitaria* sp., which, unlike the *Cynodon* sp. of Kenya, are of very low productivity and are incapable of carrying any appreciable number of cattle. Attempts are therefore being made to re-establish the natural veldt grasses by re-seeding on arable lands. This is in some cases effected by simply laying ripe cut veldt grass over the area and thus allowing the seeds to shatter over the land. Considerable success has attended these efforts, although it is disputed whether it is possible to alter permanently the stages in the plant succession without actually reproducing the conditions under which these species grow. Under the type of soil conditions at Frankenwald, it is realized that in the re-establishment of the veldt and its proper management lies the solution of the problem of these worn-out arable lands.

The various stages of the grass succession on unburnt and ungrazed veldt were seen and it is probable that such areas will ultimately revert to bush. Temperature measurements are made during and after burning veldt, and it has been shown that when the grass is really dry, very little rise in temperature is experienced during the burn, as it sweeps over so quickly. The harmful effects of heavy grazing too soon after a burn were also demonstrated, and the effect of burning on the individual grass species is now being studied. It has been shown also that the cover of grass on the unburnt land is often deceptive, due to the presence of dead material, and in many cases is no better or even poorer than on land which has been burnt.

In adition to the above, work is carried out on grasses suitable for the establishment of lawns, fairways and golf greens, and the vital necessity of the addition of humus for the successful maintenance of these stoloniferous grasses is clearly demonstrated.

The Warmbaths Pasture Research Station is situated in bushveldt, and apart from trials of a collection of grass species, the remainder of the work is largely devoted to veldt problems. The chief is that of rotation and resting, and the following experiment is in progress in order to study this:—

(1) Two animals (steers) are grazed over 18 acres all the year round.

(2) Eighteen acres are subdivided into two, and the two animals are

grazed midsummer–midwinter in one paddock, and midwinter–midsummer in the other.

(3) Eighteen acres are subdivided into three, and the animals grazed for approximately four months in each area. It is estimated that an eight-acre unit of this type of veldt is sufficient to provide 25 lb. of dry matter daily for each of two animals.

This experiment has shown very clearly that subdivision into two yields the maximum amount of herbage of high feeding value as shown by the live weight increases of the grazing animals. Subdivision into three means that the grass is grazed at too frequent intervals without having a chance to recover and seed. When the animals graze over the whole area without subdivision, grazing is irregular and uneven, and coarse unpalatable grass tends to increase during the flush periods at the further end of the paddock, while the cattle increasingly concentrate their grazing nearer to the water, with the result that there is a progressive deterioration of the herbage at one end of the paddock and an approach towards the coarse climax type of grasses at the other end. There was little, if any, difference in the rate of incursion of bush in the different areas.

It is realized that these experiments cannot be interpreted by processes of simple multiplication into ordinary farming practice, as other problems, such as distance from water, tend to enter in when the size of the grazing area is greatly increased, and the number of cattle multiplies in proportion. The next stage of these experiments is therefore their replication actually on farms, usually those of private farmers for whom the necessary fencing is provided by Government.

Studies are also being made of varying rates of concentration of stock under different systems of management, and it has generally been found that heavy concentrations of stock for short periods are preferable to lighter concentrations over long periods. In this manner least damage is done to the herbage itself and the productive capacity of the veldt is maintained at a reasonably high level.

Experiments of the type described above are repeated, using sheep as the grazing animals, in order to determine the effect of their grazing on the herbage. It is generally found that grazing with sheep unless carefully controlled may lead to a rapid deterioration in the herbage owing to their preference for the finer bottom grasses which tend to become overgrazed, while the coarser species seed freely.

Experiments on the effect of annual as compared with periodic burning of the veldt are also being conducted, but results from these are not yet available. At the Estcourt Pasture Research Station it has been found that on steep hillsides burning in strips along the contour is preferable to burning over a whole area, and also that burning may be necessary in order to prevent erosion on the steep hillsides. This is due to the fact that where there is only a shallow topsoil, a heavy accumulation of dead herbage may wash down and pull the soil with it after heavy rains, whereas if the accumulation has been removed by burning this will not occur.

Although the experiments with regard to veldt burning are for the most part still in their preliminary stages, yet they indicate that under certain conditions burning may be desirable. More experiments on the point should be carried out in Kenya in various areas, more particularly as it has been shown in South Africa that many harmful effects attributed to grass burning, such as rise in soil temperature, reduction of soil cover, etc., may not in fact be appreciable.

The work of the Leeuwkuil Research Station, Vereeniging, consists primarily of the rejuvenation of worn-out arable lands and the establishment of temporary pasture in them.

On the veldt grazing it has been shown that rotational management enables double the number of cattle to be carried as compared with ordinary unfenced veldt and the surplus grass is dealt with by a mower.

The chief problem at this station, however, is the restoration of old arable lands, as it has been found that natural reversion produces a valueless *Eragrostis* sp. herbage which is very resistant. Attempts are therefore being made to raise fertility by means of compost and green manuring to enable exotic species to be established. It has been found that Makarikari *Panicum* is giving promising results in the first year but Australian Rhodes grass has deteriorated after two years, in spite of applications of fertilizer and organic manure, which only delay this deterioration slightly. It may be necessary to keep certain of these arable areas in cultivation in order to provide the necessary feed for periods of scarcity and it is possible that insufficient attention is paid at these stations to the use of arable land for the provision of fodder; the bulk obtained is generally very much greater than that from established grasslands. It is only by the provision of large amounts of fodder that sufficient organic matter can be made for the restoration of fertility to these worn-out lands. At the present time the number of cattle that can be carried at a station such as Vereeniging, in the absence of cultivated fodder crops, is insufficient to provide enough humus to restore fertility to the worn-out lands on any appreciable scale. These points serve to stress the value of a mixed farming system in the maintenance of fertility, as opposed to a system of entirely grass farming which is being stressed in all the work visited at Pretoria.

The problem of restoration of fertility to worn-out arable lands is very acute in these aras, since natural reversion to grass produces an almost valueless herbage, so that the fertility of the soil must first be raised until exotic pastures can be established. Reversion to the original veldt conditions is estimated to take about thirty years, so that this is not a practicable solution of the problem, and artificial methods are therefore being tried to establish these natural grasses.

The large scale and detail with which all these grassland problems are being attacked by Dr. Pole-Evans' department is noteworthy, and it is hoped that as a result of my visit it will be possible to lay out more experiments in the Nakuru district on the lines he indicates.

LAYING OUT CONTOURS IN ESTABLISHED COFFEE

A farmer in Cherangani wished to contour-terrace an established coffee plantation which was badly eroding. Using a Watt's Quickset level and a Barnes staff, it was soon found that visibility was severely limited by the standing coffee bushes, and it seemed as though a very large number of level stations would be required, with loss of accuracy and the use of a great deal of time. The farmer soon decided that if he could not see through the trees, he would endeavour to see over them, and by lashing stakes to the legs of the tripod and by standing on a chair to take sights, levelling operations were carried out as speedily as in the open field.

Terrace making was carried out by hand, and the cost was less than Sh. 3 per acre.

—Note contributed by W. O. Sunman, Agricultural Officer, Kenya Colony.

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VERMIN ON FARMS

SOME SUGGESTED METHODS OF DESTRUCTION

By J. T. Oulton, Game Department, Kenya Colony

A considerable amount of damage to crops and live stock, both European and native owned, is continually being suffered through the depredations of vermin of various kinds. The five main offenders are hyenas, baboons, monkeys, bush pigs and porcupines, whilst the burrowings of moles and ant-bears are aggravating annoyances and often much besides.

Moles

Expert mole catchers, using a variety of methods peculiar to themselves, can invariably be found in every agricultural tribe, and reliance should be placed on them to get rid of this pest. Much time and endless patience are needed, and when an expert trapper is secured, a regular wage, coupled with a bonus for each mole caught, is calculated to develop keenness and bring about, if persevered in, a complete eradication.

Wa-Kikuyu and Wa-Lumbwa are experts, but each tribe uses a widely different method.

Ant-Bears

The holes burrowed in a night by these creatures are huge and when several are done in the middle of a road have often been the cause of broken springs, etc., on cars.

Carbon-monoxide from the exhaust pipe of a car is deadly. This should be conveyed as far down into their holes as possible through a length of rubber tubing attached to the end of the exhaust pipe, and from a "rich" mixture. If the hole is in a direct straight line the end of the tubing can be conveyed 12 or 15 feet down the hole by means of a long bamboo or other pole to which the end has been tied. If, however, the hole is winding a diminutive native "toto" is needed to take in the end of the tubing as far as he can crawl. Before turning on the mixture the mouth of the hole should be completedly banked up with earth. This banking up with earth prevents any possible escape of the fumes.

Porcupines

In native reserves these creatures often continue using the same holes for years despite repeated attempts by natives to destroy them by huge fires placed in and around the entrances. In the course of years the size of the burrows increases until the interior is enormous and as many as 16 porcupines have been known to occupy one burrow. Situated on the side of a hill, this burrow had eleven entrances, some disused.

Lack of thoroughness accounts for much of the want of success frequently met with. Natives trap individual animals with nooses or pits, others are waylaid and killed at night, but for completely satisfactory wiping out of numbers the following method has been found highly effective:—

In the first place it is essential to know that a hole or colony of holes is occupied. The presence or absence of fresh tracks leading into the hole can fairly readily be detected, more especially after rains. A daily inspection before operations begin is advisable in order to gauge the approximate number of animals usually in occupation. When it is seen that the maximum number ordinarily in occupation is inside, all holes except the one main hole should be thoroughly blocked,

either by first forcing branches of thorn trees as far down each hole as practicable with the aid of a long forked pole, or otherwise blocked from floor to ceiling with logs of wood, stones, etc., for as far down the hole as possible. The entrances themselves are then covered with logs, stones, brushwood, etc., and completely buried under three feet or more of earth.

Poisoned foodstuffs are then conveyed as far as possible down the one main hole by the smallest of small native "totos" available. Almost any kind of food crop may be used. If maize cobs are used they should be in the green milk stage and each cob should be cut up into three or four pieces. If potatoes, they should be of about the size of a duck's egg, and any other foodstuffs should similarly not be bigger than this. Three or four such pieces should be calculated for each porcupine occupant suspected as being present and arsenite of soda sufficient to stay on a sixpence should be inserted in a hole bored in each piece.

Finally this main hole should be blocked in the same thorough and effective way as all the other holes.

Most natives are slack in this matter of thorough, completely effective blocking up and it is here where so many efforts fail. Therefore, personal supervision is needed until one or more natives are seen to have grasped the need and can be relied upon. The reason for this insistence on thoroughness is that before the porcupines can burrow a way out hunger compels them to eat the baits and it results in a complete wipe out.

Note.—Poisoning campaigns to destroy any of the following animals must be preceded by warnings to all residents in the neighbourhood, European or native, so that dogs and stock are kept away from the area of operations. Where natives are concerned these warnings need constant reiteration and even then, native-like, cattle, sheep and goats are liable to be carelessly allowed to graze over the area. Native children especially need incessant warnings.

In the case of baboons, monkeys and pigs the poisoned foodstuffs should be put down at points in the furthest recesses of their forest haunts where stock cannot easily get it. If such points do not exist, then it may be imperative to have the area under observation by dependable natives during daylight, or else to have the poisoned material collected before stock are released in the mornings and replaced after they are herded towards the homestead in the evenings.

When domesticated dogs are present all poisoned meat put down for hyenas and remaining uneaten must be collected at daylight each morning and replaced at dusk. Even then there is a measure of risk from portions vomited by hyenas or from pieces carried by vultures and dropped. Therefore, in order to be absolutely safe dogs should be chained up during the progress of the campaign and for a period after it ends and only taken out for exercise on leash.

Baboons and Monkeys

Whatever the kind of foodstuff customarily eaten by baboons and monkeys in the area needing attention, such should be used for poisoning.

The best results will be attained if a campaign is embarked upon when all crops have been reaped. Consequently, if say, maize cobs are known to be preferred (and they generally are preferred by pigs, baboons and monkeys) then efforts should be made to procure the estimated needs from elsewhere if unavailable locally. Economically that may not always be possible. Another plan would be to late-plant a patch of maize under irrigation and guard with watchmen until ready.

Several lots of unpoisoned green cobs or other foodstuff should be placed in the selected spots. Once baboons, etc., find a meal constantly waiting for them at a certain spot they will come to expect it and their fears are allayed. But owing to their extreme wariness and suspicion something is needed in order to give the cobs, etc., precisely the same appearance they will take on when afterwards arsenite of soda is applied. This is achieved by mixing ordinary washing blue with castor sugar or else common sugar ground to a powder and in sufficient quantity to give the mixture the colour of arsenite of soda.

If natives knew that these cobs, etc., were unpoisoned many would be likely tempted to steal such. Therefore this camouflaging operation must be done by the European and without his natives' knowledge.

If attempts at poisoning have not previously been made no preliminary unpoisoned feeds will be needed except for the purpose of attracting the largest numbers to the spot. No attempt is likely to meet with much success if previous efforts have been made in recent years unless several, and may be many, preliminary unpoisoned feeds are first put down. In the latter case only small feeds, gradually increasing in size and at intervals several days apart, are advisable.

For inspection purposes the same native or natives should irregularly visit the baits. When it is apparent that the feeds are unfailingly eaten, double or treble the amount for poisoning. Sufficient arsenite of soda to cover a sixpence should be inserted in, say, a third or a fourth of a cob, each cob having been divided into three or four pieces. Three or four rows of kernels in each piece should be split down the centre and the poison inserted.

Sugar camouflaged with blue having been used for the unpoisoned feeds the same must be used to cover over the places where arsenite has been inserted in the poisoned pieces. If potatoes, bananas, mangoes, cassava, etc., are used, a hole should be bored into each piece and the same amount of arsenite as advised inserted.

If sorghum or bulrush millet is used, ripened seed heads with about 15-inch lengths of stalk attached should be placed for half an hour in a boiling solution of one cigarette tin of arsenite of soda to three gallons of water and afterwards laid out in the sun to dry on rocks or bare earth. Very satisfactory results can be depended upon from the use of sorghum and bulrush millet in this way.

Bush Pigs

In some districts bush pigs have been found most difficult animals to poison with arsenite of soda, whilst elsewhere they are stated to be easier to poison than baboons if white arsenic (arsenious oxide) is used. In any case, experience seems to show that at least double the quantity of poison found sufficient for baboons must be placed in each portion of foodstuff used for pigs.

The same remarks about the desirability of a poisoning campaign for baboons and monkeys being undertaken when all crops have been reaped applies still more in the case of bush pigs. At such time, naturally, they are keener in search of foodstuffs in the fields.

Where poisoning campaigns have been carried on continuously over a period of many months bush pigs have been known absolutely to refuse to touch any and every foodstuff when poisoned. In cases where it is found that preliminary lots of unpoisoned foodstuffs of one kind are not eaten other foodstuffs should be tried, and when all such efforts end in disheartening

failure poisoning must give place to communal drives, shotguns being used by Europeans and spears and clubs by natives.

Valuable nurseries can be protected from pigs by a trench of approximately four feet deep and three feet wide.

Unsophisticated animals will readily take mangoes, bananas, green maize cobs, ordinary and sweet potatoes, meat and the whole of the stomach parts of slaughtered stock. As in the case of baboons preliminary lots of unpoisoned materials should be laid down, and, of course, in places inaccessible to stock, but double the quantity of white arsenic or of arsenite of soda should, as previously indicated, be inserted. Sugar is not normally needed as they are voracious feeders and will take anything if previous attempts at poisoning have not made them suspicious.

In Tanganyika the following method is stated to have been successful. A quantity of cassava or sweet potatoes is pounded in a wooden mortar (obtainable from most native villages), together with some pumpkin to act as a binder. Over this about 1½ cigarette tins of white arsenic to a four-gallon petrol tinful are slowly sprinkled over the mass. When thoroughly incorporated double handfuls are placed on a piece of banana or other large leaf and distributed along the pigs' runs.

Should circumstances make it desirable all such material ought to be collected at daylight and replaced at sundown.

Hyenas

For these creatures powdered strychnine is the most effective poison. If purchased in crystal form it can readily be powdered by placing a quantity on a sheet of stout paper and then crushed with a large spoon.

The poisoning of a whole carcass is not entirely satisfactory owing to the likelihood of an overdose being eaten with the consequent danger of vomited portions being dropped far and wide. If, however, a complete carcass is used ten or a dozen deep incisions should be made at well-separated points, and moderate amounts of strychnine inserted in each. The interior of the stomach and mouth should also be treated and the entrails, etc., peppered with a reasonable amount. It is useless to give precise quantities as more or less of the carcass will be eaten depending upon the number of hyenas that turn up.

A more satisfactory way to use a carcass is to drag it around by oxen for miles and finish up at some selected tree with stout, overhanging branches. A number of chunks of meat are then cut off, each chunk about ½ lb. in weight, and powdered strychnine sufficient to cover about a quarter of an inch of a small penknife inserted deeply into holes bored in each chunk. These should be distributed at widely separated spots under bushes or in tufts of grass and the spots marked by sticks for future inspection. The remainder of the carcass should then be hauled up on the branch of the tree by a rope or block and tackle and left dangling at a height just about sufficient to prevent its being grabbed by hyenas. Hyenas attracted by the dragging will find some of the chunks of meat and later, when the carcass gets really "high," every hyena in the neighbourhood will be attracted to it. Further chunks can be cut off after the first lot has been taken and finally, when every hyena appears to have been disposed of, the carcass can be lowered and burnt. Any carcass left on the ground or hung up on a tree needs to be protected from vultures during daylight by a thick covering of thorn bushes, grass, etc.

Hyenas are not particularly suspicious, nor delicate and dainty feeders; in the uncommon event of their refusing to eat ordinary chunks of poisoned meat, it is advisable to try inserting the strychnine in a length of gut. The ends are then tied into knots and this prevents all chance of the poison being detected.

In thickly settled areas the above methods are ruled out owing to the widespread danger to domesticated dogs, cats, etc. The only feasible method to employ in such instances is to drag, say, a couple of legs of zebra or other animal for several miles slowly behind a car or other vehicle, ending up at some selected spot. A European or a trained native can wait up in the vehicle with a flashlight torch or spotlight and use a shotgun on whatever hyenas follow up the drag.

It is desirable to emphasize strongly that when poisons are used the greatest care and watchfulness must constantly be exercised to prevent mishaps. Every article used in operations with arsenic must be destroyed when the work is finished, i.e. tins, etc., pierced and crushed to prevent further use; bottles broken up and buried deeply; gunny bags, paper, etc., burnt and ashes buried; water in which arsenic has been mixed for soaking, etc., must be emptied into a deep hole which is then filled in. All poisons should be plainly labelled and kept under lock and key and under no circumstances should they be stored near foodstuffs. If arsenic comes in contact with the ground the surface should be scraped and buried deeply.

Arsenic being a mineral is indestructible and therefore deep burying is the only safe procedure in regard to everything that has been in contact with it. Strychnine being of vegetable origin is destroyed by fire, and weather conditions dissipate its potency after a time.

Should a person be poisoned an immediate emetic of either salt or mustard with tepid water, and plenty of it, should be given, and the patient rushed to the nearest hospital.

LOSS OF FERTILITY ON CLEARED FOREST LAND

"It is now recognized that in the wet areas of the tropics where there are no well-marked dry seasons it is essential, if soil fertility is to be maintained, for the land to be kept under a cover of vegetation. Luxuriant virgin forest growth is not necessarily an index of the suitability of land for agricultural occupation. It has been found in many parts of the wet tropics that land when cleared of its forest cover rapidly becomes leached and loses it fertility. This is particularly the case where soils are acid. Soils under such conditions cannot be maintained in cultivation, except for limited periods, unless heavy dressings of manure are applied or they are planted with tree crops which provide satisfactory shade to the soil and an abundance of leaf fall. Even then it has been found in the West Indies and in certain parts of Africa that certain tree crops will only be reasonably productive for long periods if they are heavily mulched or interplanted with cover crops. In coffee, lime and cacao cultivations, the value of the use of heavy mulchings with grass and other vegetable refuse has been proved in several areas and the importance of the use of cover crops has been fully demonstrated in the case of several crops in the East and elsewhere."

—Sir Frank Stockdale in his *Report on a Visit to Malaya, Java, Sumatra and Ceylon*, 1938.

NOTES ON FENCING

By B. R. D. Eccles, Agricultural Assistant, Department of Agriculture, Tanganyika Territory

The series of articles by Elmer [2] that appeared recently in this Journal provides a mine of information for the practical farmer, and the following notes are put forward to supplement a few of the points raised by him or to offer alternatives which have been found more suitable by the writer during his experience in South Africa and Tanganyika.

Types of Fencing

The old-fashioned heavy gauge wires have been found to be more suitable than the modern light high-tension wires, because they are much more visible to stock and game and are not nearly so brittle. In practice in South Africa the heavier wires are still almost always preferred, and No. 6 for plain and two-strand No. 10 for barbed wire are recommended.

The suggestion that the closer the posts are spaced the easier it is for animals to get through is open to doubt. Very few animals try to climb a fence though quite a number attempt to jump them and don't quite succeed. If the fence is tight and strong they will be thrown back, whereas if it is at all slack they will be caught up and entangled in it, doing untold damage to themselves and the fence. Further, in a tight fence, the barbs immediately penetrate the skin of any animal which pushes against it, thus warning the animal of danger before any attempt has been made to push through the fence.

The more rigid a fence is the better it will serve its purpose. Standards or posts should not be more than 45 feet apart and 30 feet is about the best average spacing. For general stock the lower wire should not be more than six inches from the ground, otherwise small stock and even donkeys will crawl or roll under. It has been found than 14 lb. standards are too light and nothing under 16 lb. should be used, while strainers should be 400 yards apart.

Pig Fencing

Where they are possible, stone walls are naturally far better than anything else for pigs. For large paddocks heavy gauge barbed wire, spaced at five-inch intervals with posts at six-foot intervals and laced every two feet with No. 6 plain wire, will be found to be cheaper and to last much longer than any netting, even the most expensive. The bottom wire should be as close to the ground as possible, while the fence need only be three feet high.

Strainers

Planting strainers from 4 ft. to 6 ft. in the ground without staying is useless. Struts and anchors are in themselves often of little value unless put in very carefully. By far the best strainer is the double post or gate type, which was illustrated and recommended by Bosch [1], though in his illustration the anchor is in a weak position. The strength of this strainer lies in the principle of a rectangle and diagonal, so that the anchor should be placed just outside the outer post (Fig. 1).

This method of construction is quite simple. The two posts should be 8 in. in diameter, while the top rail, which is mortised in, should be 4 in. in width. Great care must be taken that the two posts are exactly in the line of the fence and they should be inserted about 3 ft. into the ground and be well tamped. When the posts are in, a separate hole must be dug for the anchor about 6 ft. outside the outer post and true to the line of the fence. The hole should be 3 ft. deep

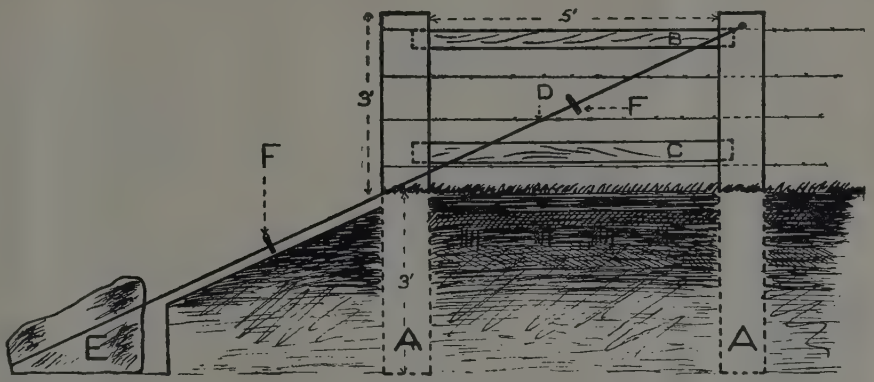


FIG. 1

TWO POST STRAINER

Showing improved position of anchor.

A = 8 in. diameter concrete posts.
B = 4 in. wooden top rail.
C = 4 in. wooden bottom rail for extra support in soft soil conditions.
D = Strainer.
E = Anchor.
F = Points at which to twist strainer wire.

and large enough for a fair-sized stone weighing from 200 to 300 lb. The side adjacent to the post should be sloped so that the anchor wires lie straight. These should pass through a hole in the top of the inner post and on either side of the outer post. They must then be twisted up tight between the anchor and outer post and the outer and inner posts. In very soft soil an extra rail about 12 in. from the ground is advisable.

The wires of the fence should pass through the inner post and be tied to the outer. With barbed wire the wire should be slightly strained and then cut off about 2 ft. short of the inner post and joined with an 8 ft. length of plain wire for the final strain and tying.

Where a turn is made in the fence, three posts are used and two anchors. The outer post serves both lines of fence. This type of strainer (Fig. 2) will be found more effective than any number of struts and anchors.

DROPPERS AND LACING

Droppers should be placed every 10 ft. or less, if used. Lacing, though tedious, is preferable. Special soft lacing wire is obtainable, but No. 8 plain wire is quite good.

The following is a good method of lacing (Fig. 3): First, a wire spacer must be made in accordance with the spacing of the wires of the fence to be laced. The simplest form is a piece of flat iron with slots cut in for each wire at the correct spacing. The notches should be about $\frac{3}{4}$ in. deep. A rod for measuring the distance between the lacings should be made and also a rod for measuring the actual length of the lacing wires. The latter must be 18 in. longer than twice the height of the fence between top and bottom wires, i.e., if the distance between top and bottom wires is 4 ft., the lacing should be cut 9 ft. 6 in. long.

When these have been made, cut a lace according to the measuring rod. Twist one

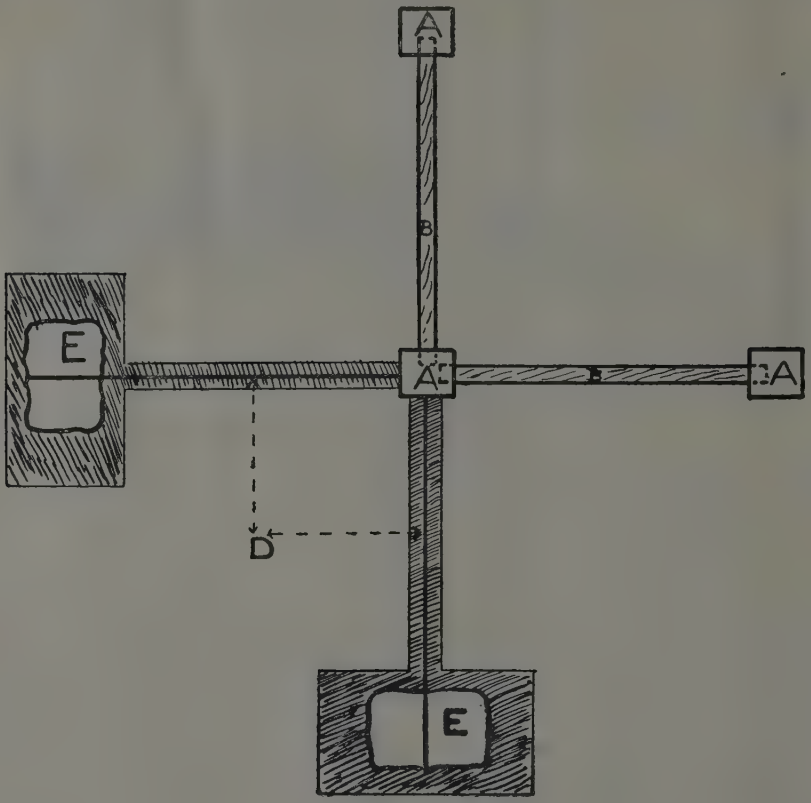


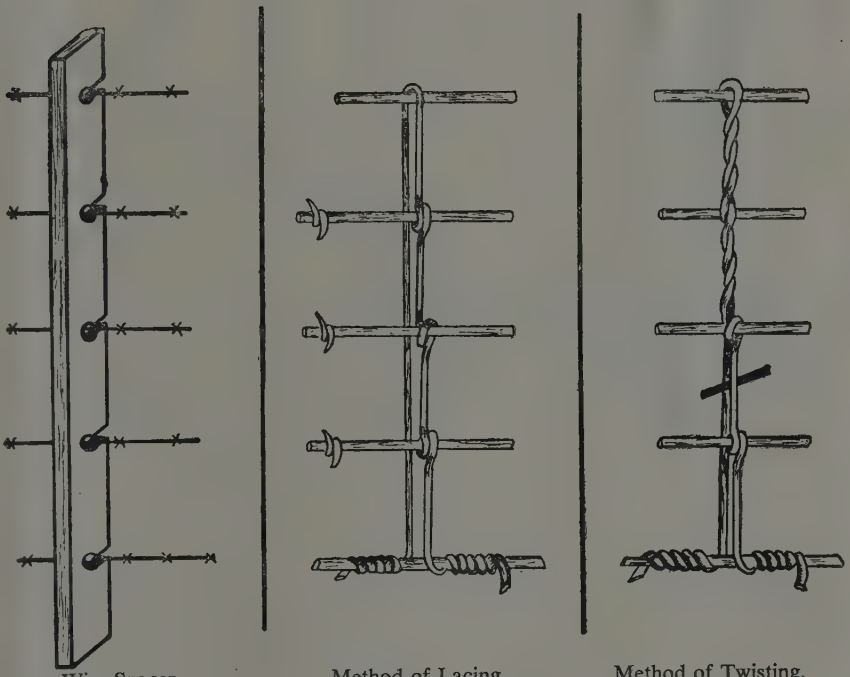
FIG. 2
THREE POST STRAINER
Showing position of double anchors to corner strainer.

end tightly round the bottom wire of the fence. Place the spacer on the fence close to the lace and see that each wire is in its respective slot. Hold the spacer in position with the left hand and pull the lace up the back of the fence firmly. Twist once round the top wire and bring down the front of the fence, taking one turn round each strand till the bottom is reached. Now, using a small tommy bar, twist the back and front strands of lacing together between each strand of fence.

The advantage of lacing is that if bent by an animal the laces immediately spring back into position, while if a dropper is bent it remains so, pulling the whole fence out of shape.

DRAWING FENCING STANDARDS

Sometimes one has to take up an old fence and in hard soil it is often very difficult to raise the standards. For this purpose a very effective and simple tool (Fig. 4) can be made out of an old pick



Wire Spacer. Method of Lacing. Method of Twisting.

FIG. 3

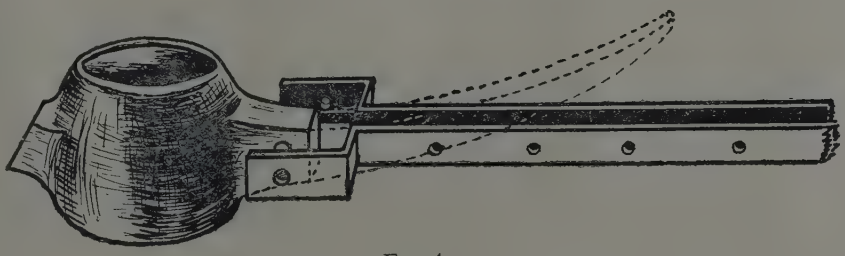


FIG. 4
STANDARD PULLER
Made from old pick head.

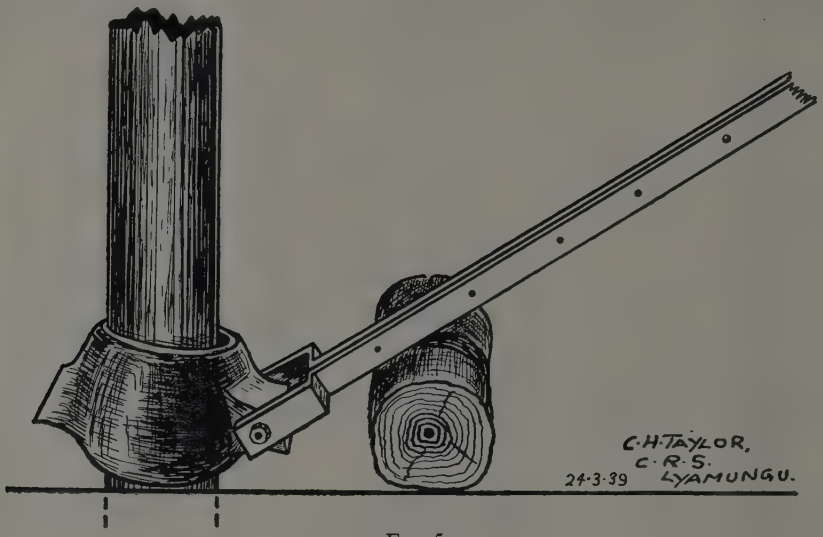


FIG. 5
STANDARD PULLER
In position for lifting.

head and a couple of pieces of flat iron about 5 ft. long and 2 in. wide and $\frac{3}{8}$ in. thick. For this purpose old plough handles are suitable.

The ends of the pick head are cut off, one as close as possible to the eye and the other about 3 in. from the eye. Through the latter a $\frac{9}{16}$ in. hole is drilled. Now rivet the two pieces of flat iron together, leaving the last 6 in. at one end unriveted. Drill a $\frac{9}{16}$ in. hole through this end and then splay the two pieces so that the drilled end of the pick head will fit between them firmly but with freedom for movement. Assemble handle and head with a $\frac{1}{2}$ in. bolt and nut. Care should be taken to see that the pick head can move freely between the shoulders of the handle.

The tool is now ready for use. The method of operation is to slip the pick eye down the standard to be drawn till it reaches the ground. Then, keeping the eye at the bottom, raise the handle and put a block of hardwood under it to act as a fulcrum. When the handle is depressed the pick-head edges bite into the metal of the standard and the standard is pulled up with it. After three or four strokes it is quite easy to pull out the remainder of the standard by hand (Fig. 5).

SOME TIPS ON FENCING

(1) Do not strain wires before 10 a.m., when they will be fairly well expanded. If possible, strain on a hot day.

(2) When straining and tying, train natives to stand on the side of the posts remote from the side on which the wires are laid. If a strand breaks they are much less liable to be injured.

(3) Strain the top wire first, but do not tie off very firmly. Then start from the bottom and work up. Finally, re-strain the top wire.

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[2] Elmer, L. A. (1937-38).—"Farm Fencing, Parts I to V," *East African Agricultural Journal,* Vol. III, Nos. 2–6, pp. 96, 209, 294, 342, and 478.

THE POULTRY FARMER'S LOSSES

By M. H. French, M.A., Ph.D., Dip. Agric. (Cantab.), Chemist, Veterinary Laboratory, Mpwapwa, Tanganyika Territory

The financial losses incurred by poultry farmers are normally much higher than is generally realized, and at intervals may reach such proportions that not only do running expenses show a deficit, but large inroads are made into working capital through the decimation of flocks by disease. Even on farms that show a profit, such losses are often considered unavoidable and incidental to the business of breeding, hatching, rearing, and maintaining flocks of high egg-laying strains. I hope in this article to focus the attention of East African poultry keepers on some of their main sources of loss, and, by doing so, to indicate where a greater concentration of effort is most likely to be repaid.

The chief sources of trouble may be summarized as (*a*) losses during the incubation of eggs, (*b*) mortality during brooding (*c*) mortality during adolescence, (*d*) mortality and other losses in the laying flocks, and (*e*) troubles in the breeding pens. I shall deal with each of these in turn, and mention the chief sources of trouble, together with a few factors of feeding and management that will help to minimize the losses.

Hatching Losses

Considerable sums of money, besides a large amount of valuable time and energy, are lost annually through the poor hatching of incubated eggs. In the more established poultry industries of the older countries these losses are tending to increase, but it is not possible to say this with certainty for East Africa. Some losses are inevitable, but their reduction to the absolute minimum must lead to greater profits, not only because less eggs will be wasted but also because poor results may so delay the replenishment of the laying pens that a valuable market may be missed.

The most important cause of poor hatching results is undoubtedly infertility in the eggs chosen for incubation, but the factors influencing the number of *fertile* eggs that fail to hatch will first be considered.

The first is the management of the incubator itself. The mechanical perfection of modern machines has reached a very high level and, provided the instructions of the manufacturers are followed implicitly, no serious troubles should be looked for from this source. Care must, however, be taken to see that the temperature of a machine remains steady at the correct level for a few days before any eggs are put inside. In this connexion farmers in East Africa should make a special point of getting the right capsule for their particular altitude, because a capsule which works efficiently at sea level will not do so at 5,000 ft. or any other high altitude.

Water must be kept in the tray provided for it in the incubator. In the absence of water or when insufficient moisture is contained in the air in the machine, the incubating eggs lose weight faster than is desirable. There is an optimum level for the relative humidity of the air in the incubator, and variations above or below this level lead to poorer hatching results. The machines of a reputable firm are so constructed that they give the desired relative humidity if their working instructions are followed.

In East Africa it often happens that the water supply is hard. When incubators that depend for their heat on a tank of hot water have been in use for some time hard water will deposit a scale on the walls of the tank, and if this becomes excessive, hatching results may be reduced. If such a deposit is likely, and this can be judged from the condition of the ordinary household kettle, the tank should be filled only with rain or softened water.

Another point that needs emphasis is the selection of a suitable room for incubation, otherwise hatching returns will be low. I have seen incubators in many diverse situations, such as in a sitting-room, a veranda, a food store, etc. More attention needs to be given to this point in East Africa. The incubator should be placed in a room that varies as little as possible in temperature. It must never be placed in a draught, nor where it is likely to be disturbed by vibrations, nor in a room that is being continually entered. Nor must it be sited where sunlight can strike directly on the machine. A well ventilated room, not a stuffy cellar, should be chosen. It may also be worth recording that I have known troubles arise and erratic temperatures develop because a machine was sited where rats could play on it and upset the temperature-regulating rod.

A further factor not generally recognized is that the position of an egg in the incubator can markedly affect the hatching results. Eggs placed with the large end uppermost give the least number of chicks "dead in the shell," and those placed with the small end uppermost the largest number.

Once the eggs are put in the machine they need not be touched for two days, but after that they should be turned round, still keeping the large end uppermost, every morning and evening until the nineteenth day. After that the machine should not be opened until the majority of chicks have hatched. It was once the custom to cool the eggs in the incubator every day, but modern practice shows that this is not necessary because sufficient cooling occurs during turning. Care is needed both when touching the machine and when turning the eggs to see that no jarring takes place; carelessness in this may cause serious injury to the developing embryos.

All incubators are provided with holes to allow an adequate amount of ventilation. These holes must be kept clean, otherwise the developing embryos may be seriously weakened, if not actually killed.

One further operating fault commonly encountered is that of frequently opening the machine to see how many chicks have come out. The machine must not be opened more than necessary during the final stages.

Low hatching results are sometimes due to insufficient care in selecting the eggs for incubation. Only well-shaped eggs of average size and good shell structure should be chosen.

It is usual to collect eggs from the breeding stock for several days so as to have enough to fill the incubator at one filling. At the time of laying, fertile eggs have actually started to develop and the conditions of storage before incubation become important. It is usually stated in textbooks that eggs can be held up to ten days, but my own experience in Tanganyika indicates that efforts should be made to keep the storage period down to about three days. It is generally agreed that eggs for incubation should be held at a temperature low enough to prevent embryonic development, and this means that they should be stored below 60° F. (15.5° C.). The practice of leaving eggs lying in nest-boxes during the heat of the day is wrong; they should be gathered

frequently and put in a cool place immediately. Holding eggs for too long an interval or at too high a temperature reduces their hatchability. Dirty eggs should not be incubated nor should dirty eggs be washed and then put into the incubator, because washing removes their protective cuticle and allows them to evaporate too rapidly.

It is known, too, that the mortality rate during embryonic development is much higher at the fourth and nineteenth day than at any other time, and that the most critical period is at the nineteenth day. It has been shown by Payne [*J. Am. Assn. Inst. Invest. Poult. Husb.* 6. (1919). 9] that 65 per cent of the fertile eggs that die during incubation do so during seven of the 21 days (viz. the 4th to the 6th, and the 18th to the 21st); 48 per cent die during the last four days.

Nutritional factors influencing hatchability have also received considerable attention recently, and the point of most interest to East African poultry farmers is that there should be an adequate amount of animal protein in the rations of the breeding stock. When the dietary proteins are derived solely from vegetable sources embryonic mortality is high, especially during the second week of incubation. Supplementing such diets with certain animal proteins corrects this high loss in the second week. Meat meal and milk by-products are of great value for correcting poor hatching results due to dietary causes, but the meat meal loses this property if heated too highly during its preparation. Mixtures of protein concentrates are of greater value than individual supplements. Wherever separated milk is available it should form a regular part of the rations of breeding birds.

Vitamin D deficiency is also an important cause of poor hatchability, but it has been shown that if the birds receive over 200 hours of sunshine a month they can elaborate sufficient of the vitamin for normal hatchability. If the insolation rate is lower than this, at the time of incubation, it will be advisable to include 2 per cent of cod liver oil in the mash of the breeding birds.

One of the most important environmental factors is the provision of good green grass runs, because the birds are then able to correct many deficiencies in their diet. In the dry season, green foods such as lucerne or grass should be provided daily.

High rates of embryonic mortality occasionally result from inbreeding without careful selection of the birds. Characters for abnormal development, and lethal factors, can be inherited. Usually these are recessive characters and lie hidden in the strain of birds until birds with the same hidden defect are mated together.

Heavy egg production need not necessarily depress the hatchability. If this heavy production is obtained on well balanced rations supplying adequate amounts of animal protein experience at Mpwapwa shows that hatchability may be quite normal.

Mortality during Brooding

The rearing of chicks from the time of hatching until laying begins is a matter that requires a good deal of attention and skill. An inexperienced poultry farmer usually finds the losses at this stage very considerable.

The temperature of a brooder must be kept under control, and the amount of heat adjusted so that the chicks neither crowd round the source of heat nor huddle away in the farthest corners. During their first week of life the temperature should be about 90° F. (32° C.) and this should be reduced

slowly to harden off the chicks so that no heat is needed after eight weeks. Chilling causes high mortality rates; overheating is just as harmful and leads to colds and delicate constitutions. In East Africa one of the major problems is to maintain the right temperature in the brooder during the heat of the day and also during the cold nights. Large differences in air temperature between night and day characterize many parts of East Africa. The temperature in the brooder will tend to follow these changes unless it is carefully regulated; this is particularly bad for young chicks and may result in diarrhoea and other troubles.

Brooders must supply ample fresh air and the floors must be kept dry. Chicks do not thrive in damp quarters. Great attention is also needed to maintain the brooders perfectly clean, and this is just as important in the late as in the early stage. Chicks need sunlight, otherwise they will fail to grow out properly, and they should be allowed access to enclosed grass runs. Sunlight is also one of the best disinfectants and drying agents for the brooder compartments. Brooders must be disinfected at regular intervals to reduce the risk from disease.

The construction of the brooder must be such that any risk of fire is negligible. Much loss has been suffered by poultry farmers through neglect of this obvious precaution.

The feeding during this stage is most important, because it affects not only the rate of growth but also the age at which the birds commence laying. There is no longer any doubt about the need for a well balanced ration, supplemented by separated milk. Milk products have a very great beneficial effect on the growth and health of chicks; they should be fed always fresh or always soured, but never fresh one day and sour the next.

The mortality rate during the first fourteen days of life reaches a peak value about the fifth day, and can be expected to reach 8 per cent even under good conditions of management. Later the mortality rate decreases, but lack of sanitation, overcrowding or any other factor encouraging diseases may lead to whole batches of chicks being lost. Overcrowding is a particularly bad fault and occurs commonly. It leads to weakened constitutions, trampling and inadequate feeding of the weaker individuals, and encourages the spread of many diseases such as colds, roup, and coccidiosis or other internal parasites.

Losses during rearing, therefore, cannot be entirely eliminated, but they can be kept within reasonable proportions by correct management, the provision of adequate space and air, the maintenance of the correct level of heat, and the proper feeding of the chicks.

In East Africa there is one further source of large losses to poultry farmers, namely *siafu*. Much attention should be paid to the siting of the brooders and a constant watch kept when these ants are on the move. I have known large batches of chicks completely wiped out overnight by *siafu*, and so far as I know the only methods of preventing attacks are by making the house inaccessible or by putting down hot ash to drive the ants away once the brooders appear in danger.

Mortality during Adolescence

The mortality during adolescence should be small, but diseases can wipe out large numbers. In East Africa the most common diseases are probably fowl pox and fowl typhoid. The latter is extremely prevalent and can cause high mortality in both native-owned and European-owned flocks. Care must be taken to see that no native fowls are

brought near the pens, and it is advisable that all birds when they leave the rearing pens should be vaccinated against these two diseases.

Again much trouble may be caused by overcrowding. A house which is large enough for three-months-old birds becomes too crowded as these birds reach maturity. Many diseases are favoured by this fault of management, such as colds, roup, coccidiosis and intestinal and external parasites. Trouble from external parasites may be avoided by putting the stock only into clean, recently disinfected houses, and then by using dusting powders as soon as any parasites are seen on the birds. Internal parasites may become very serious if the young birds are put into runs that have been badly fouled by previously infected birds. It is a good plan to run the growing pullets on fresh land each year.

In Europe many losses are caused by the increasing incidence of fowl paralysis, but so far this disease has not become widespread in East Africa. However, another form of leg weakness if often encountered, particularly in the young cockerels of the heavy breeds. This is usually associated with the feeding of a too forcing ration. It appears that the birds outgrow their strength and that they are then either weakened by parasitic infections which would not harm a normally developed bird, or their legs become too weak to support their body weight. This leg weakness shows itself by knocking hocks and in-bent legs, and later by the bird being unable to walk, or moving itself on its hocks. In nearly every case the affected birds not only appear leggy but actually possess longer leg bones. In one outbreak I have seen, large amounts of boiled meat were being fed; in another, large quantities of liver were being given. A less forcing ration seems to be the precaution to take against this trouble.

Mortality and Other Losses in Laying Flocks

The main diseases causing mortality in laying flocks are fowl typhoid and fowl pox, but these can be guarded against by vaccination. Roup may cause serious losses by throwing the birds out of production and may cause appreciable mortalities. Much loss in East Africa is caused by vermin. Leopards, honey-bears, wild cats and jackals may break into a poorly constructed house and destroy large numbers during a night. Every effort must be made to get really vermin-proof houses, because the honey-bear is a particularly formidable adversary and shows amazing powers of breaking into poultry houses.

By far the greatest cause of deaths in laying flocks is, however, troubles in the reproductive system. Many birds die from such causes as a ruptured oviduct or being egg-bound, or from the development of tumours or cystic oviducts. These troubles have been increasing steadily during the last fifteen years in England, and the same is probably true for East Africa. This increase in deaths from reproductive troubles is usually associated with the big increase in egg production that is steadily proceeding. Naturally the more eggs a bird lays the greater is the risk that the reproductive disorders will occur. On the other hand, the Mpwapwa figures indicate that ruptured oviducts (which is the most common disorder) occur in moderate and even poor layers, so that high egg yields are not the sole, though they may be a predisposing cause. The only way of countering this type of loss is to breed from strains of birds that show a low mortality rate from this cause.

Apart from deaths there are many other factors that reduce the egg output and so cause considerable financial loss. Thus certain strains of a breed are good layers but another strain of the same

breed may be inherently incapable of high egg yields. These poor strains eat much food and are a source of much loss; it is important to purchase and maintain only birds of a good strain. Again, only birds from healthy, vigorous breeding pens should be kept in the laying pens. Farmers are often tempted to buy in what appears to be a cheap lot of birds, and are just as frequently disappointed by their laying results.

Just as it is true that poor-laying strains will never give high egg yields no matter how well they are fed, it is equally true that high-laying strains will also not lay well if they are incorrectly or inadequately fed. Properly balanced rations must be fed, which contain a correct level of animal protein, preferably proteins from different sources, such as meat meal and separated milk. A shortage of minerals will also reduce egg yields and lead to a large number of soft or thin-shelled eggs. These thin-shelled eggs are a cause of much loss, because they may not only break during transportation, but may cause a whole consignment to be spoilt.

Moulting is a normal function of fowls, but if the ration contains insufficient protein the moult may be unduly protracted and egg yields unnecessarily depressed. During moulting care is needed to see that the birds get a properly designed ration. Certain strains of fowls are non-broody; others are often broody, and much lower profits are made from them.

Arrangements must be made to ensure that the laying flocks get an adequate amount of shade, and water should be constantly in front of the birds or the egg yields may be considerably lowered. Efforts must also be made to keep the flocks free from parasites, because hens that are weakened or irritated by parasites do not lay their best.

Troubles in the Breeding Pens

By far the greatest cause of lack of fertility and weak embryos in the hatching eggs is due to an appalling carelessness in selecting the birds for the breeding pen. Often farmers choose their breeding stock solely on egg records, and it is generally the case that insufficient care is taken to breed only from healthy, vigorous birds of good constitution.

It is true, however, that even when carefully selected birds are mated, their fertility is sometimes low. This can be because the cock is sterile, or because certain hens are barren. Also it appears that certain cocks will not mate with particular hens, and if there is a high degree of infertility the cock should be changed at once.

The age of hens has influence on fertility; the older the hen, the greater the tendency of her eggs to be infertile.

FERTILIZING VALUE OF PASSION-FRUIT SHELLS

An analysis given in the *Agricultural Gazette of New South Wales* for 1st August, 1939, shows the amount of manurial constituents in passion-fruit waste. On a dry-weight basis, one ton of the material was estimated to contain—

10 lb. Lime (CaO)
4½ lb. Phosphoric acid (P_2O_5)
27 lb. Nitrogen (N)
84 lb. Potash (K_2O).

Figures such as these cannot, of course, be taken as exactly applicable to similar material available at East African centres of production of passion-fruit juice, for they will vary somewhat according to soil. It is clear, however, that a considerable manurial value is represented, and should not be wasted. It would best be utilized by being added to the compost-pit. The dry ton of waste is about equivalent in plant-nutrient content to 1 cwt. sulphate of ammonia, plus 1½ cwt. sulphate of potash, plus 10 lb. double superphosphate. G.M.

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